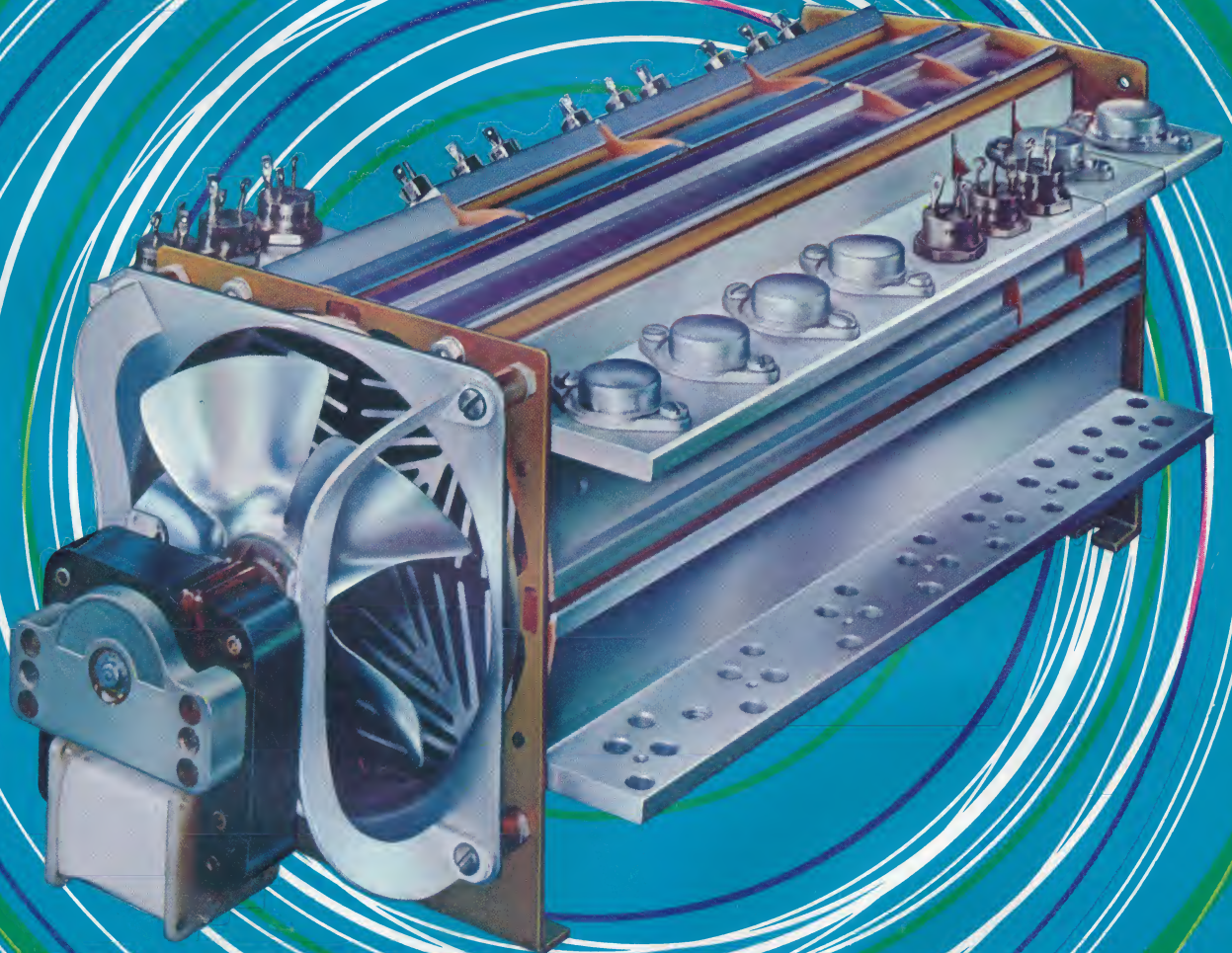
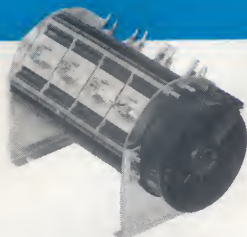


SEMICONDUCTOR COOLING PACKAGES

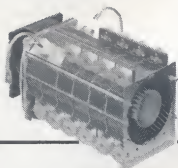




SERIES FCA-700 minimum size and weight for mounting up to 32 semiconductors. Available with "A" type mounting shelf module or "B" type module to accommodate stud-mounting devices only. "A" and "B" modules may be combined in a single package. 400 cps fans standard, d-c fans available on special order to meet voltage requirement.

Page No.

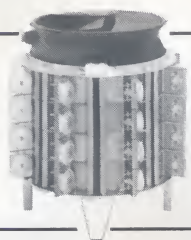
4



SERIES FCA-800 also uses the "building block" method of construction. Available in "A", "B", or combination of these two types of modules. Shelf on "A" type module may be horizontal or vertical. Somewhat more compact than FCA-820 below. 60 cps fan. a-c/d-c converter available.

6

SEE FRONT AND BACK COVERS



SERIES FCA-820 new . . . commercial package. This new design increases air flow and thermal efficiency at reduced cost. "A", "B", or combination of these modules may be used. Furnished with new, economical WAKEFIELD Deltaire 40, 60 cps Fan unless other brand specified. a-c/d-c converter available with Rotron fan.

8

SERIES FCA-900 cools as many as 104 stations per package. Has about three times as much capacity as Series 700, 800 and 820, so can cool up to three times as many semiconductors. Modules are arranged in octants instead of quads and each heat sink has more fin area than the series above. 60 cps commercial fan as well as 60 or 400 cps military fan. a-c/d-c converter available.

10

SERIES FCA-1000 most economical package for cooling very high current rectifiers and SCRs, including $3\frac{1}{4}$ " square 650 amp rectifiers. Largest capacity package available today, and lowest thermal impedance per station. Only one output busing connection required with straight line layout of semiconductors on a long single isolated module. 60 cps fan.

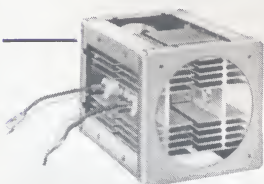
13

SEE BACK COVER

SERIES FCA-1100 has excellent performance at the lowest cost for a few high power devices or a greater number of medium power rectifiers and/or SCRs mounted in a straight line. Same advantages as FCA-1000 with pigtail breakout and electrical commoning of studs possible with only one output busing connection required. 60 cps fan. a-c/d-c converter available.

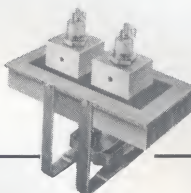
14

SEE BACK COVER



TYPE FCA-1122 fits in same outline as Series 1100 but has two banks of sinks in front of fan. With thinner mounting ledge, it may be used to cool groups of TO-3, TO-36 or other power transistors as well as rectifiers and SCRs. 60 cps fan.

15

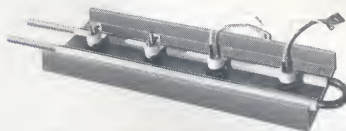


SERIES FCA-1200 The plane of the finned base plate is perpendicular to the fan axis. This causes mushrooming of the air flow with attendant surface washing and turbulence. Base plate temperature rises of 10° to 20°C per 100 watts of applied power are easily achieved with the different versions of assemblies. 60 cps fan.

16

SERIES 151 DELTA COATE is a superior isolating film which provides electrical isolation and good thermal conductivity between a device and a module.

17



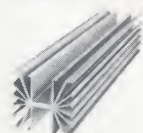
SERIES LCP-10 Liquid Cooled Plates satisfy requirements for very high power dissipation rectification and regulation systems.

18



SPECIAL COOLERS OR ASSEMBLIES to satisfy custom requirements: engineered cooling packages, terminal board assemblies on packages, special extrusions, unique hole patterns, or special fabrications.

20



SERIES FSE EXTRUSIONS are available from stock in 2', 4' or 6' $\pm\frac{1}{4}$ " lengths, or will be cut and deburred to any specified length on special order. Also available are prototype requirements or production quantities of parts fabricated to customer specifications from these extrusions.

22

Introduction	below
Confined Airflow Series	3
Open Airflow Series	12
Liquid Cooled Series	18
Special Assemblies	20

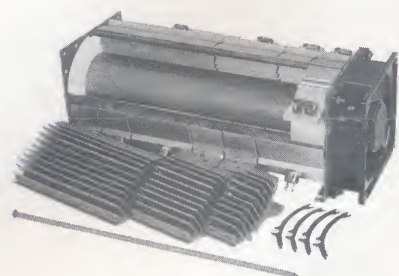
SEE SPECIFIC PRODUCT INDEX TO LEFT

General Introduction to Semiconductor Cooling Packages

For a quick and important insight into each type of Cooling Package, read the captions for each in the Index.

This catalog is provided in five basic groupings:

1. Confined Airflow Series FCA-700, 800, 820 and 900 packages form their own ductwork for confining the airflow and all modules can be electrically isolated. Each series utilizes the modular "building block" cooler units or modules which may be combined in a variety of ways to construct the desired cooling system. Pictured below is a partially assembled Series 800 Package to show modular construction. Underneath that is seen the completed assembly.



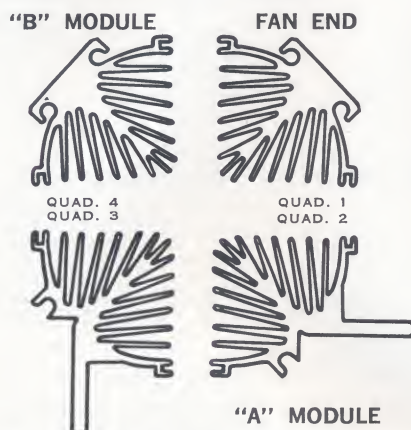
2. Open Airflow Series FCA-1000, 1100 and 1122 utilize standard WAKEFIELD King Size Heat Sink extrusions for high power rectifiers and SCRs. Devices are mounted in a straight line which facilitates pigtail breakout. Use of one long sink permits electrical commoning of studs. See page 12 for complete general discussion.

3. Series FCA-1200 uses a single base plate with staked, soldered, or extruded heat sinks that directly face the airstream. No modules are used, but the application of Delta Coate 151 dielectric film to the base plate allows electrical isolation of the devices mounted on this surface.

4. Liquid Cooled Plate Series LCP-10 provides an economical means for removing heat from the very high power rectifiers utilizing the advantages of liquid cooling.

5. Special Heat Sinks or Assemblies are an important part of WAKEFIELD ENGINEERING'S daily business. Custom requirements are welcomed.

The end view of a Series 820 Package is shown below with four quadrants made up of "A" shelf type modules and "B" type modules for stud-mounting devices. This explains pictorially that "A" and "B" modules may be used together in the same package and may even be combined in the same quadrant. The "A" type provides excellent accessibility to the semiconductor and permits mounting transistor types with feed through leads such as TO-3. "B" type modules eliminate the additional increment of thermal resistance inherent in the "shelf-type" designs. Series 700, 800 and 820 are built in quadrants and Series 900 in octants. The 900 will accommodate three times as many semiconductors per assembly as the others. The individual cooler modules are electrically isolated from one another and from ground. This eliminates the need for mica insulating wafers and their attendant thermal resistance.

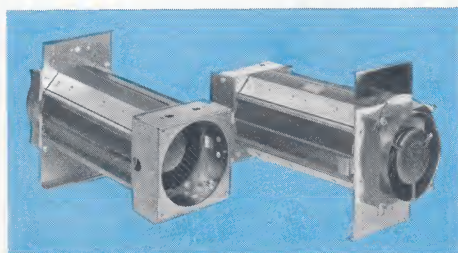


Series 800 and 820 provides for either horizontal or vertical positioning of the ledges on the "A" type modules.

CUSTOM ENGINEERED FCA ASSEMBLIES

Standard module sizes and drilling configurations shown on pages 5, 7, 9 and 11 are supplied without tooling or setup charges. However, special drilling configurations, module lengths or end plates represent a large portion of WAKEFIELD ENGINEERING production. Satisfying custom requirements is accomplished with the latest, most economical methods. Engineering assistance encompassing thermal design, mechanical design and general cost reduction is available.

Shown below are two views of a custom engineered Series FCA-800 Package. One of the special end plates provides a box to form a chassis enclosure for mounting power resistors. These are cooled by the outlet air leaving the Package, which eliminates finding another method or fan to dissipate their heat.



How to Match the Confined Airflow Series FCA-700, 800, 820 or 900 Packages to your semiconductor cooling requirements

The curves provided with each Series were obtained from tests conducted under actual operating conditions. The proper utilization of these curves will enable exact determination of the temperature rise of each semiconductor to be cooled. By converting cfm to lbs. per hour, the same data may be used at elevations other than sea level.

The procedure for designing a confined airflow heat sink assembly for a group of semiconductors is a four step process as follows:

1. **Estimate** the size module required to cool each semiconductor.
2. **Arrange** the modules into quadrants for Series 700, 800 and 820 or octants for 900.
3. **Analyze** and tabulate the performance of each module using the data provided in the curves of Figures 1-4.
4. **Refine** and adjust the estimated design as necessary and, as a final check, carry any changes back through steps 2 and 3.

Original estimates must be based on an assumed airflow. The arrangement step involves equally filling each quadrant or octant with modules. The analysis step requires understanding and proper use of the data included in the curves. See the "Sample Specification Form No. 16A" on page 4 which lists the application data required to permit the design of a complete cooling package.

The objective of the next three paragraphs is to elaborate upon the first three steps above.

1. **Estimate:** For each semiconductor which is to be cooled, determine the thermal resistance which will be required from its heat sink to ambient. Then from Fig. 2 determine the airflow per quadrant available for an 8 unit length package for the particular fan desired. (For Fig. 1, 2, 3 and 4, refer to pages on Series 700, 800, 820 and 900.) Using the 8 unit length airflow per quadrant or octant, which we trust will be conservatively low, proceed to Fig. 1. Choose the cooler module for each semiconductor which has a sufficiently low thermal resistance, keeping in mind the fact that the "B" type modules are for stud-mounting semiconductors only.

2. **Arrange:** Having chosen a module for each semiconductor to be cooled, it is now necessary to arrange them in a package. The package length must be at least as long as the longest module, and is expressed in multiples of the shortest standard cooler, Model 701, 801, 821 or 901. For example, a 4 unit length package describes an assembly which could contain 4 each 701 coolers per quadrant, or 2 each 702 coolers per quadrant, or 1 each 704 coolers per quadrant. The total number of coolers in each of these assemblies would be 16, 8 and 4 respectively. There must be an equal number of unit lengths of modules in each quadrant although it is permissible to fill adjacent quadrants or octants with any combination of "A" or "B" modules having the correct length. In order to fill a package, it may sometimes be necessary to use one or two modules which are larger than thermally required.

3. **Analyze:** From the curves of Fig 2 or Fig. 3, the actual airflow per quadrant through the determined package length can be ob-

tained. Having determined the airflow per quadrant and returning to Fig. 1, a list may be made of the thermal resistances, cooler to airstream, of the chosen modules. By multiplying these thermal resistances and the known power to be applied to each module, the direct or self-produced temperature rise above ambient for each module can be calculated. This direct temperature rise is that which would occur if there were no other upstream modules heating the airstream. The temperature rises induced by upstream units must now be calculated using the curves in Fig. 4. These must be added to the direct temperature rise to obtain total temperature rise of each downstream module. The logic of the curves of Fig. 4 may not immediately be appreciated. Therefore, a brief dissertation follows to make our method more clear.

As air proceeds along the cooling package, accumulating thermal energy from the individual modules, its temperature increases. One must consider the increased airstream temperature when calculating the actual temperature rise of a downstream module. The temperature of a downstream module, however, cannot be accurately predicted by considering only the four quantities, (1) upstream input power, (2) flow rate, (3) specific heat of the air, and (4) the inlet air temperature. A fifth parameter, the locations of the various upstream power inputs, must also be considered.

The following is an attempt to explain why. If one considers cooling air flowing along a hot fin it can be appreciated that the air passing close to the fin will be hotter than air passing along farther from the fin. As the flow proceeds along the fin, this hotter air will mix with the cooler air but a finite amount of time and distance is required for this mixing to take place. If this mixing has not been completed before the airstream reaches the fin of a successive module, then the temperature of the air to which the succeeding module's fin surface is exposed will be greater than the average airstream temperature.

The curves of Fig. 4 are given to permit accurate computation of the semiconductor mounting surface temperature of any downstream module. Each module upstream of a given downstream module induces to that downstream module an incremental temperature increase which may be calculated by the use of these curves. The induced temperature increase caused by each upstream unit must be considered separately and then all increments summed to yield a total temperature increase of the downstream unit being considered. Because there is very little mixing of air between adjacent quadrants, the only modules which need to be considered are those upstream modules which are in the same quadrant as the module whose temperature is being calculated.

If a group of semiconductors running at equal power on a quadrant or octant is to be kept cooled with equal case temperatures, the downstream devices must be assigned a greater length of module than upstream devices. This weighting of spacing is also effectively done on a long module with a number of common collectors or common stud semiconductors mounted on it.

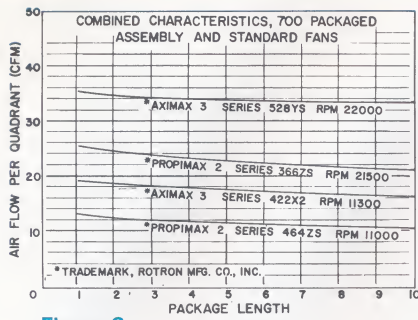


Figure 2

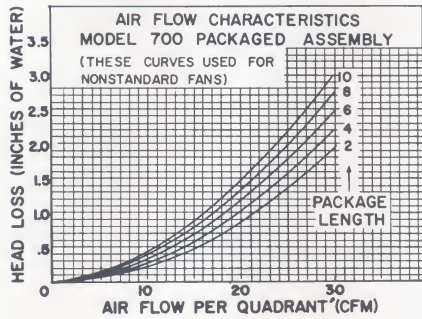


Figure 3

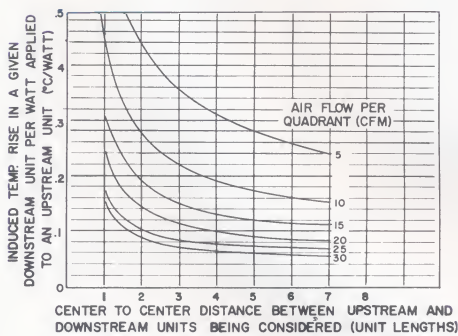


Figure 4

Figure 6
32 701A-A
Modules with
Rotron Aximax-3 Fan

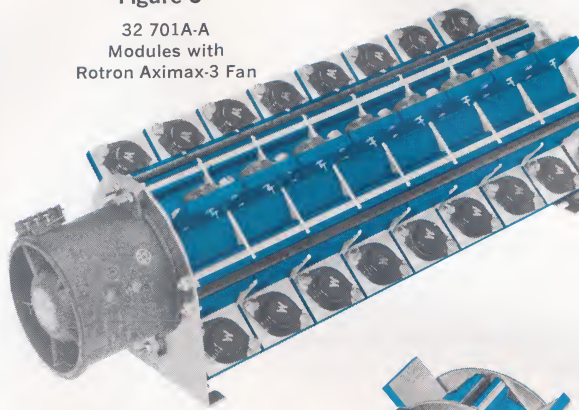


Figure 7
4 each 704B-Q
Modules cooling
high power SCRs

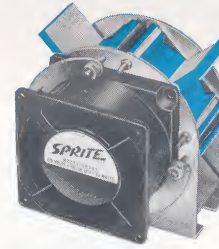
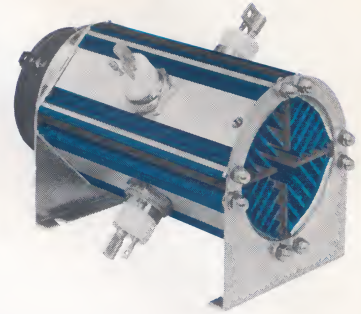


Figure 8

4 701A Modules with
115v 50/60 cps Rotron
Sprite Fan

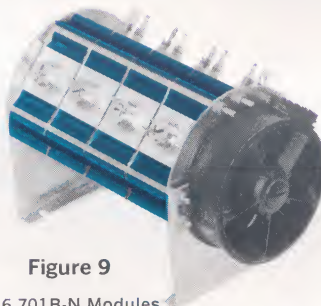


Figure 9

16 701B-N Modules
with Rotron
Proprimax-2 Fan

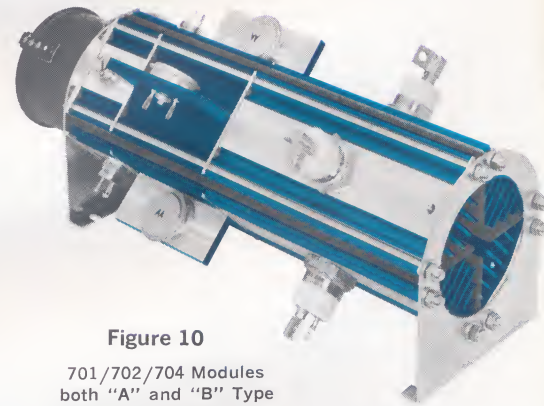
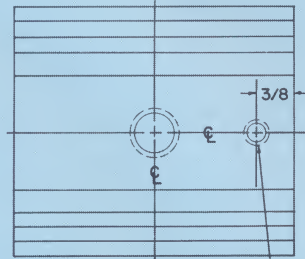
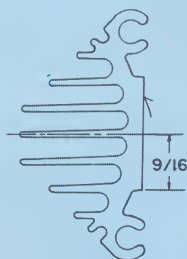
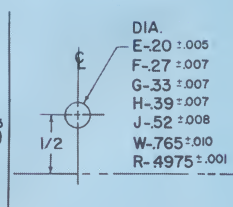
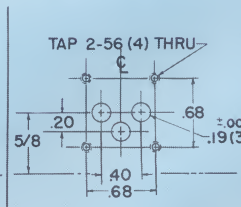
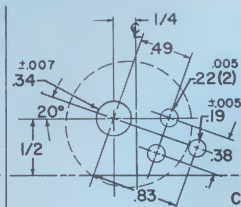
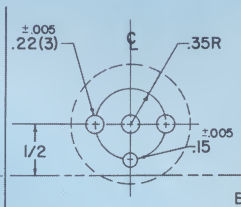
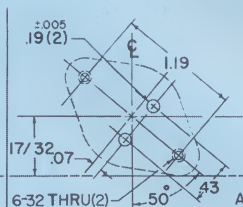
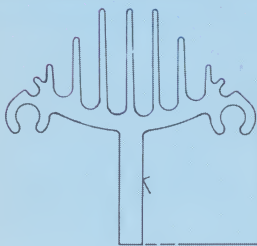


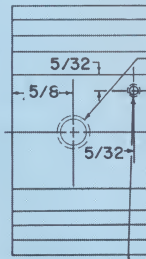
Figure 10

701/702/704 Modules
both "A" and "B" Type
with Rotron Aximax-3 Fan

Standard Semiconductor Mounting Configurations



* 1/4-20 TAP, 3/8 DEEP
MODEL 702 & 704



MODEL 701

L-8-32 -5/8 DEEP
M-10-32 -5/8 DEEP
N-1/4-28 -5/8 DEEP
P-3/8-24 -3/4 DEEP
Q-1/2-20 -7/8 DEEP
S-3/4-16 -1.00 DEEP
X-5/16-24-3/4 DEEP
(TAP DEPTH + 1/4-0)

6/32 TAP, THRU*

NOTES:

1. Location of mounting groups on coolers to be within $\frac{1}{32}$ of true position.
2. Unless otherwise specified, tolerance on decimals $\pm .010$.
3. Mounting surface $\sqrt{64}$ and free of finish.
- *4. For electrical connection.

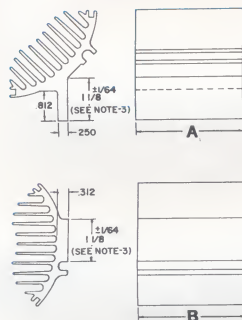
The Confined Airflow Series FCA-800 Package also is available in "A", "B" or a combination of these two types of modules. The shelf on "A" type modules may be horizontal or vertical.

This "ready to use" FCA-800 Assembly lends itself particularly well to breadboarding activity. It affords optimum performance at minimum cost, and is available in commercial or military versions. Package design further permits safe cooling of other temperature-sensitive components, such as tantalum capacitors. Exhaust air may be flushed through racks and cabinets to eliminate the need for additional blowers.

If standard configurations do not meet requirements, WAKE-FIELD ENGINEERING wants to assist with special solutions to your cooling problems.

Thermal characteristics were determined by mounting open-junction thermocouples in holes drilled beneath the semiconductor. The proper utilization of these curves in Figures 1 - 4 will enable exact determination of the temperature rise that will result under any required set of circumstances.

STANDARD "A" AND "B" TYPE MODULES



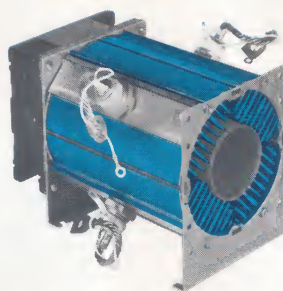


Figure 5

4 804B-Q Modules with
"T" type end plates
to permit clearance
between rectifiers and
mounting surface

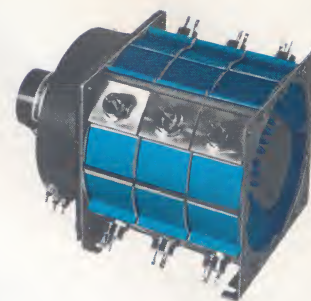


Figure 6

12 801B-N Modules with
"S" type end plates

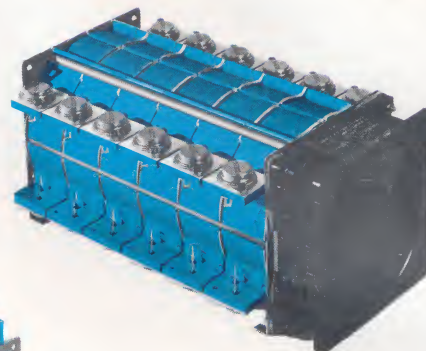


Figure 7

24 801A-A Modules,
ledges horizontal,
short end plates,
Rotron Muffin Fan

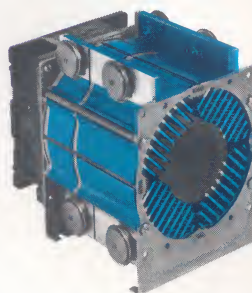


Figure 8

1 801A-B and 1 802A-B
Module per quadrant
with ledges vertical
and "T" type end plates
for clearance

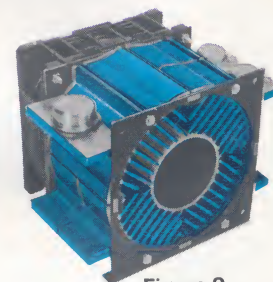
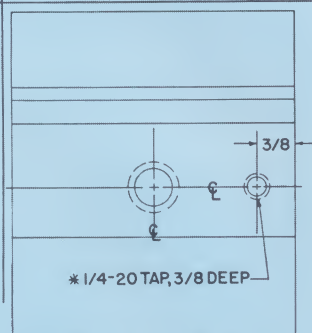
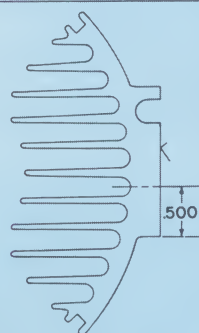
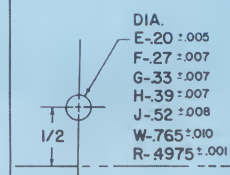
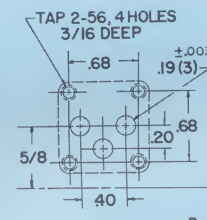
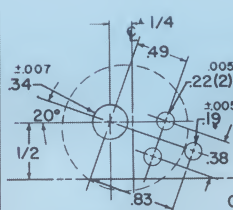
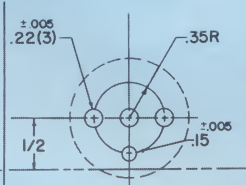
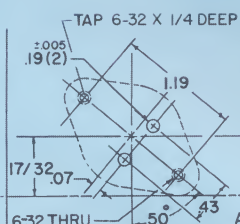
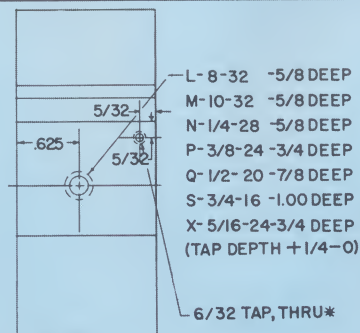


Figure 9



MODEL 802B & 804B



MODEL 801B

NOTES:

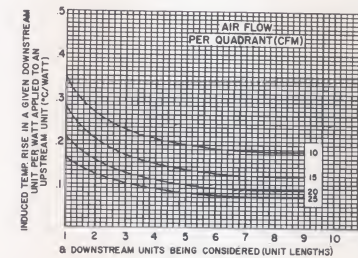
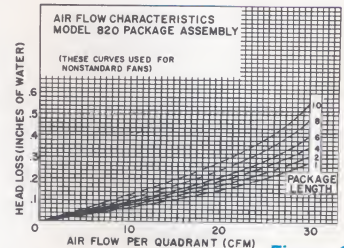
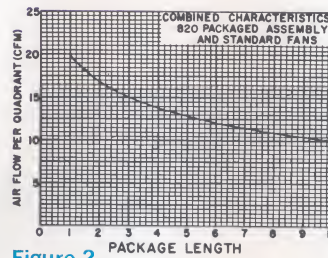
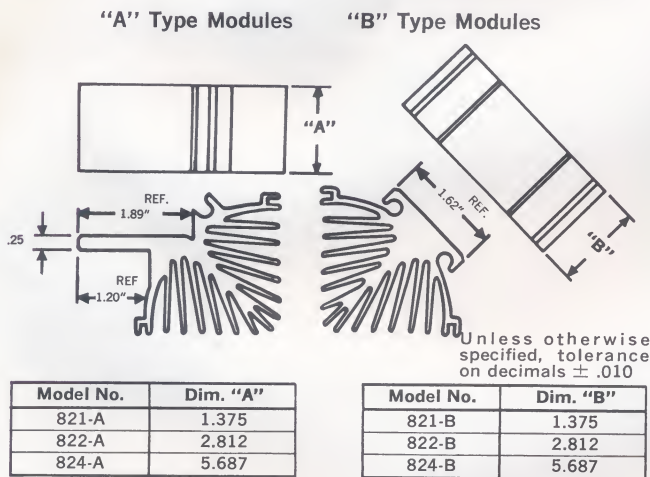
1. Location of mounting groups on coolers to be within $\frac{1}{32}$ of true position.
2. Unless otherwise specified, tolerance on decimals $\pm .010$.
3. Mounting surface $\sqrt{64}$ and free of finish.
- *4. For electrical connection.

*4. For electrical connection.

New fin extrusions have been designed to pass and utilize greater airflow than the Series FCA-800 Assembly. Both airflow and thermal efficiency are increased with reduced cost.

To provide adequate cooling for up to 32 stations or more per package, the Series FCA-820 Cooling Package may be assembled in a variety of ways to obtain the desired cooling system. Using the "building block" method, WAKEFIELD ENGINEERING assembles the correct module length for all semiconductors in a circuit into a package. No ducting or baffles are needed. Individual modules are electrically isolated from each other and from ground. However, electrical busing and tie-busing are available as required.

The low thermal resistance of these efficient packages reduces the number of semiconductors needed for given regulating circuitry. Two types of modules are available for the Series FCA-820: Type 820-A "shelf type" module for easy semiconductor mounting and maintenance, and Type 820-B module designed to provide lower thermal resistance for stud-mounted components. See Figures 6 and 7 for a Model FCA-820-A, Figure 8 for a FCA-820-B and Figure-9 to see how "A" and "B" modules can be in the same quadrant.

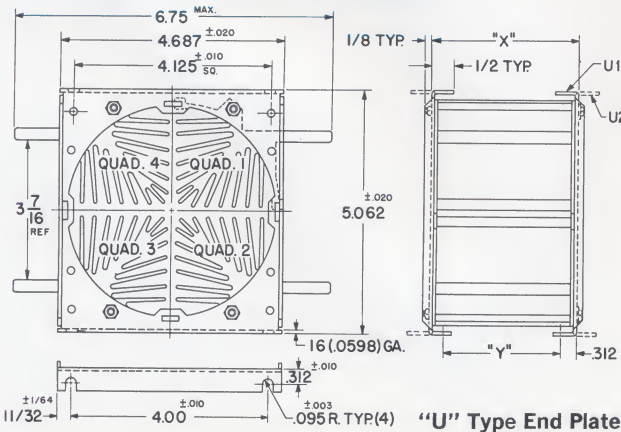


Marking and stencilling of component positions, such as "Q" and "CR" numbers, can be provided. Marking is most economically done on the edge of the "shelf" on "A" type modules and on the flat mounting surface of "B" type.

Special module lengths and drilling of mounting configurations to customer requirements represent a large portion of WAKEFIELD production. We are set up to handle this business economically and engineering assistance is available for specials. Note that EBY transistor sockets are shown on the bottom "shelf" on an "A" type module in Figure 10. These are available for fast T0-3 mounting and easy field replacement.

High Potential Ratings: Quad-to-quad, 1500v a-c is standard. Module-to-module, 700v a-c is standard. Module-to-end plate, 700v a-c is standard. But, using X-type insulation, up to 3kv a-c may be achieved in each of these.

STANDARD QUADRANT ORIENTATIONS



HOW TO ORDER: Refer to page 6 on FCA-800 Assemblies. If "A" type modules are to be mounted with ledges vertical, or if semiconductor clearance is required below the package with "B" type, specify "V" type end plate described below. "S", "T", "U" and "V" type end plates are interchangeable between 800 and 820 Assemblies except "V" type must be used in the latter for vertical "A" modules. Deltaire 40 Fan standard or specify other brand, Page 9.

EXAMPLE:

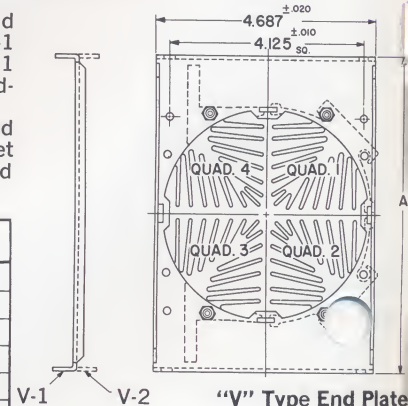
Quad. No.	Module No. of Modules Front to Rear
1	821-A-A1 821-A-A1 821-A-A1
2	821-A-A1 821-A-A1 821-A-A1

Quad. No.	Module No. of Modules Front to Rear
3	821-A-A1 821-A-A1 821-A-A1
4	821-A-A1 821-A-A1 821-A-A1

"U" type end plates. Howard Cyclohm fan.

4 types of end plates are available and all are flanged top and bottom. U-1 and U-2 are the short end plates. V-1 and V-2 are the tall ones for "A" modules with ledges vertical. U-1 and V-1 have mounting feet turned in. U-2 and V-2 have mounting feet turned out. Series 800 S and T end plates may also be used.

Package Length	Dim. "X"	Dim. "Y"
1	1.64 $\pm .03$	1.01 $\pm .03$
2	3.07 $\pm .04$	2.45 $\pm .04$
3	4.51 $\pm .05$	3.88 $\pm .05$
4	5.95 $\pm .06$	5.32 $\pm .06$
5	7.38 $\pm .07$	6.76 $\pm .07$
6	8.82 $\pm .08$	8.20 $\pm .08$
7	10.26 $\pm .09$	9.63 $\pm .09$
8	11.69 $\pm .100$	11.07 $\pm .100$



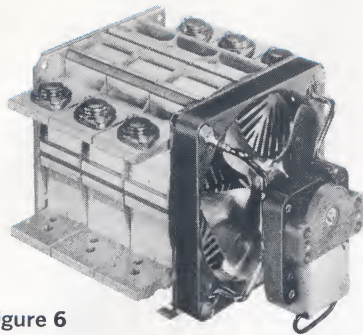


Figure 6

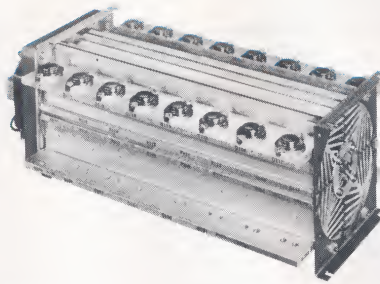


Figure 7

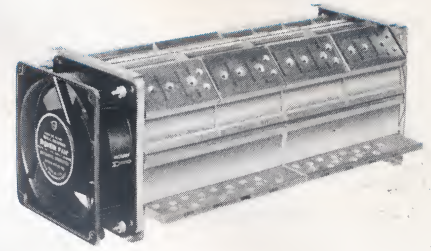


Figure 8

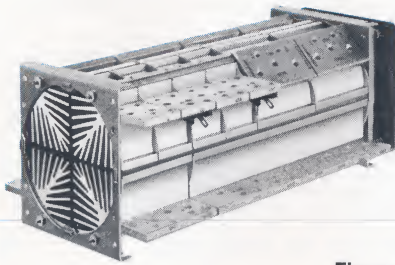


Figure 9

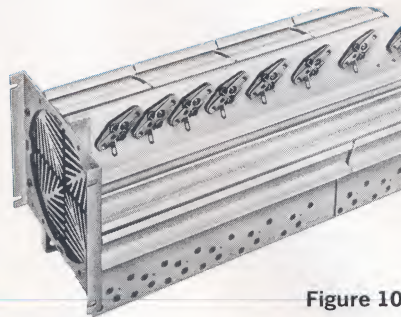


Figure 10

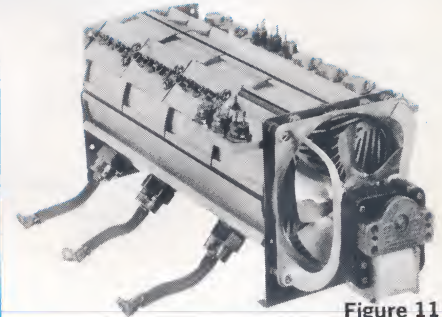


Figure 11

Electrical busing, such as tie-busing etc., can be provided to your special requirements. See busing ring on end of FCA-820A Cooling Package in Figure 7.

Fan Mounting Hardware:

Screw and tenz nut: C.R. Steel per QQ-S-633, Cad. Plate and Gold Iridite per QQ-P-416-A Class 2, Type 2.

Spacer: Aluminum 6061-0 per QQ-A-270 a.Amend.I.

Fan Gasket: Polyethylene foam (white).

115v 60 cps FANS available:

- * Deltaire 40. (See front cover or Fig. 11)
- ** Howard Cyclohm.
- *** IMC Boxer.
- *** Rotron Muffin
- * Provided if other fans are not specified. Motor does not shield inlet. Standard filter and grill assemblies are not available.
- ** Motor does not shield inlet. Standard filter and grill assemblies are not available.
- *** d-c to a-c converter available.

NOTE: Fans are not available separately.

STANDARD MATERIAL AND FINISH:

Heat Sinks: Aluminum 6063-T5 per QQ-A-200. Clear Iridite per MIL-C-5541.

End Plates and Nuts: C.R. Steel per QQ-S-633. Cad. Plate and Gold Iridite per QQ-P-416-A Type 2, Class 2.

Threaded Rod: Passivated Stainless Steel, Type 303 per MIL-7-S-7720 or Type 416 plus X per QQ-S-764a Condition A.

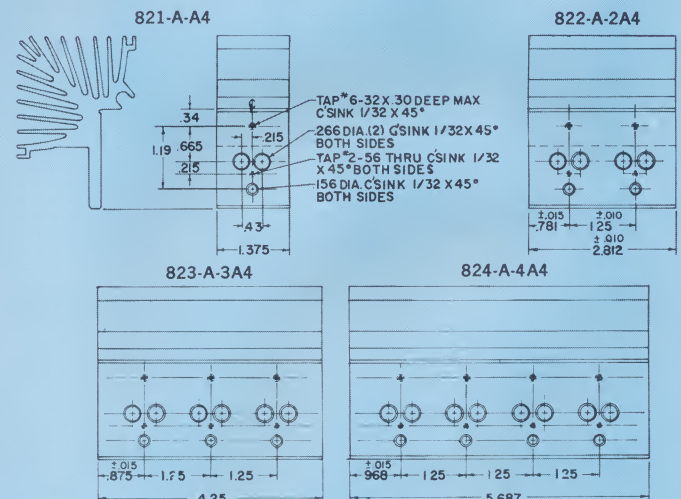
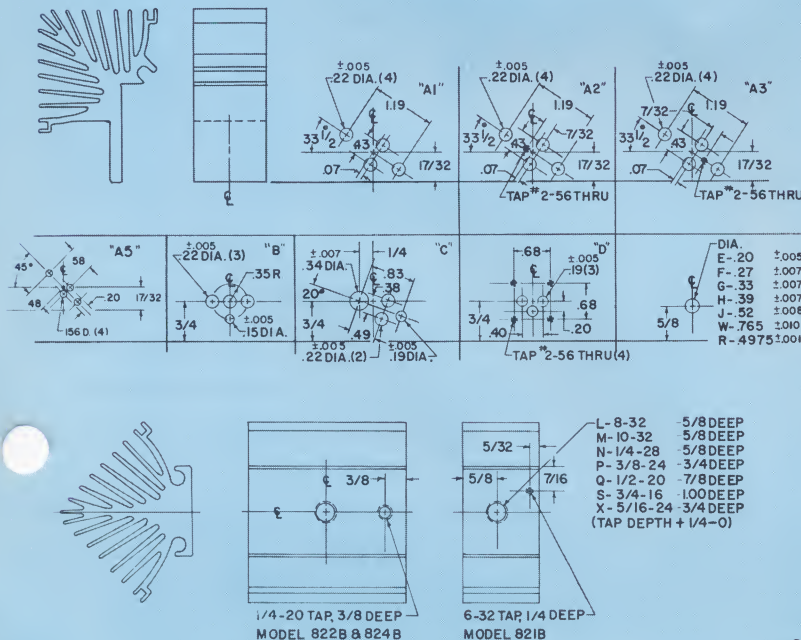
Insulator Strips, Segments and Tubes: Phenolic XXX per MIL-P-3115. Note: These are also available in Glass Base Epoxy G-10 per MIL-P-18177-GEE.

Standard Semiconductor Mounting Configurations

Drilling of special mounting configurations is done economically. This work is welcomed and engineering assistance is available.

"A2" fits EBY socket. "A2", "A3" or "A4" fit Cinch triangular sockets. See Figure 5 for module dimensions.

High production tooling is available for drilling "A4" configurations in 1, 2, 3 and 4 unit length modules as shown below:



NOTES:

1. Location of mounting groups on coolers to be within $\frac{1}{32}$ of true position.
2. Unless otherwise specified, tolerance on decimals $\pm .010$.

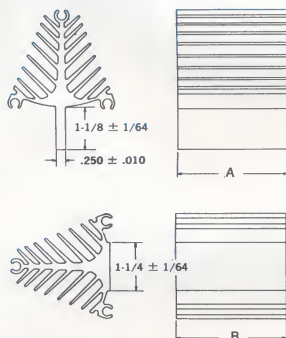
If you wish WAKEFIELD to help with the design of your package, phone or mail information per Sample Specification Form No. 16A, page 4.

The Confined Airflow Series FCA-900 Assembly has about three times as much capacity as Series 700, 800 and 820. Up to 104 stations may be cooled in a single Series 900 Package because modules are arranged in octants instead of quadrants and there is greater fin area on the heat sinks.

Stud-mounted semiconductors are readily accommodated on the "B" type cooler module. Other semiconductor types utilize the "A" type module which provides excellent accessibility to the devices. "A" and "B" modules may be used in same assembly. To permit maximum heat transfer from the semiconductor case to the cooler, the area on which the semiconductor is mounted is machined to a 64 microinch finish after all other operations. This is guaranteed flat to within $\pm .001$ inches/inch.

The characteristic performance curves in Figures 1 - 4 were obtained from carefully controlled tests. Conditions simulated those that are experienced under actual operating conditions and environments.

STANDARD "A" AND "B" TYPE MODULES

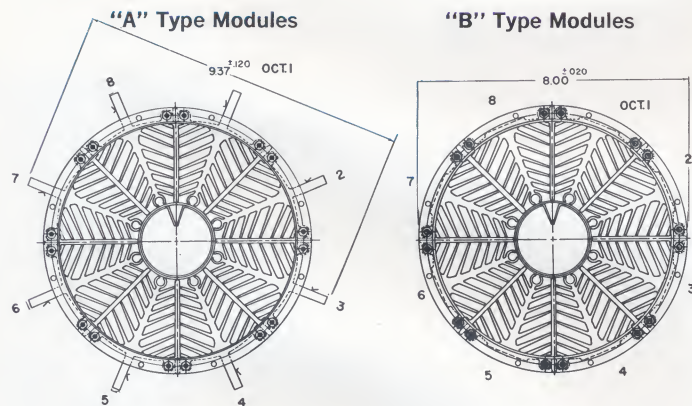


Model No.	Dim. A
901A	1.375
902A	2.812
904A	5.687

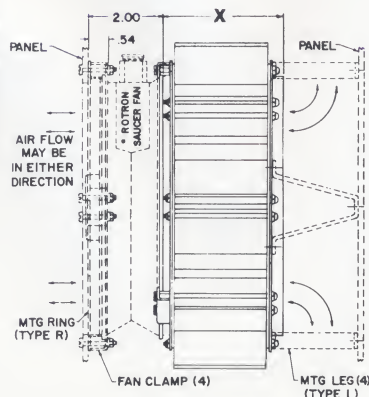
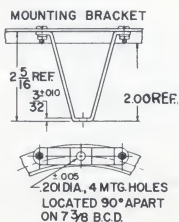
Unless otherwise specified, tolerance on decimals $\pm .010$

Model No.	Dim. B
901B	1.375
902B	2.812
904B	5.687

STANDARD OCTANT ORIENTATIONS



Package Length	Dim. X
1	2.250 $\pm$.030
2	3.687 $\pm$.040
3	5.125 $\pm$.050
4	6.562 $\pm$.060
5	8.000 $\pm$.070
6	9.437 $\pm$.080
7	10.875 $\pm$.090
8	12.312 $\pm$.100



THERMAL CHARACTERISTICS OF STANDARD 900 SERIES COOLERS (FORCED CONVECTION)

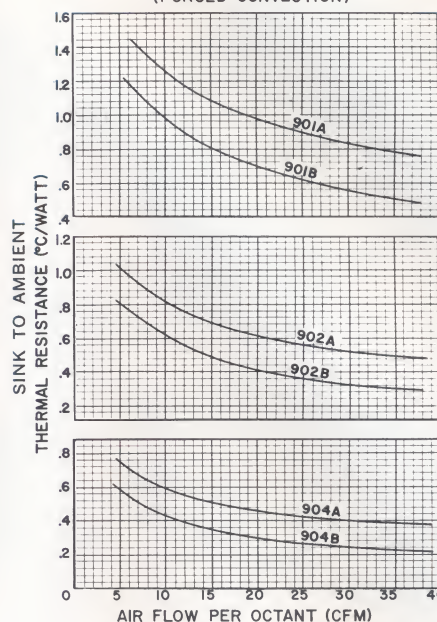


Figure 1

FANS: 60 cps commercial fan as well as 60 or 400 cps military version. a-c/d-c converter available. **Standard:** Rotron Feather Fan, Type 103, 115v, 50/60 cps, single phase, nominal 20w power required. **Optional:** Rotron Feather Fan, Type 203, 230v, 50/60 cps, single phase. If Saucer Fan is desired, please give complete Rotron specifications for type wanted.

STANDARD MATERIALS AND FINISHES

Heat Sinks: Aluminum 6063-T5 per QQ-A-200. Blue Anodize per MIL-A-8625 Type II.

End Plates, Fan Clamps and Mounting Bracket: C.R. Steel per QQ-S-633, Cad. Plate and Gold Iridite per QQ-P-416-A Type 2, Class 2.

Nuts and Screws: C.R. Steel per QQ-S-633, Cad. Plate and Clear Iridite per QQ-P-416-A Type2, Class 2.

Threaded Rod: Passivated Stainless Steel, Type 303 per MIL-7-S-7720 or Type 416 plus X per QQ-S-764a Condition A.

Insulator Tubes: Phenolic XXX per MIL-P-79 Type PBE (natural).

Insulator Segments: Phenolic XXXP per MIL-P-3115-PBE-P (natural).

Insulator Spacers: Black 6512 Polypropylene.

NOTE: Insulator Tubes, Spacers and Segments also available in Glass Base Epoxy, G-10 per MIL-P-18177-GEE (natural green).

Hypot Ratings: R.M.S. volts, 60 cps a-c.

	Standard	X Type Insulation
Quad-to-Quad	1.5kv	3kv max.*
Module-to-Module	700v	3kv max.*
Module-to-End Plate	700v	3kv max.*

* For X Type Insulation, specify maximum Hypot required and if needed both Quad-to-Quad and Module-to-Module or Module-to-End Plate.

ORDERING INSTRUCTIONS

1. State the number of FCA-900 Packages required.
2. For each octant, starting at the fan end, list the modules required with the suffix letter denoting the desired mounting accommodation. See Octant Orientations to the left.
3. Specify Type L (legs) or Type R (ring) Mounting Brackets shown in drawing to the left.
4. If Package is to be supplied complete with fan, indicate the model desired.

Example: 30 FCA-900 Packages consisting of these octants:

- | | |
|--------------------------|---------------------------------------|
| 1: 901A-A/904B-MPM | 5: 901A-A/901A-A/901A-A/901A-A/901A-A |
| 2: Same as Octant 1 | 6: 905A-BBBB |
| 3: 904A-AA/901B-P | 7: Same as Octant 3 |
| 4: 902B-LM/902B-Q/901A-D | 8: 901B-Q/902A-B/901A-A/901A-A |
- Type L Mounting Brackets. Rotron Feather Fan Type 103.



4 901A-B Modules
per octant with "L"
type mounting
brackets and
Rotron Military
Saucer Fan



A Series FCA-900 Package is used to cool transistor regulators within the power supply of the Milgo Electronic Corporation Model 4100 Analog Computer.



13 901A-A Modules per octant
which totals 104 Modules

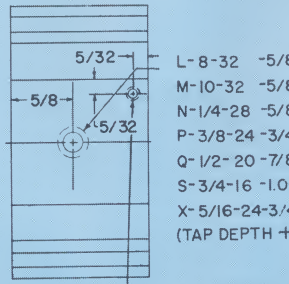
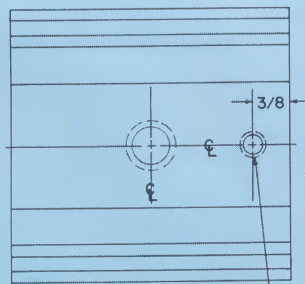
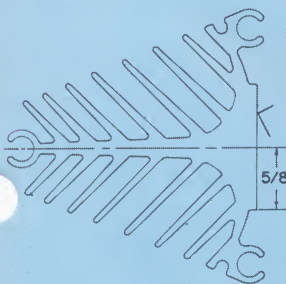
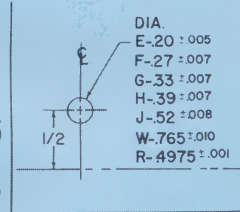
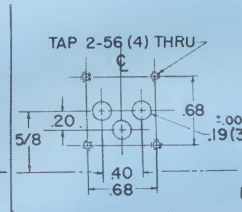
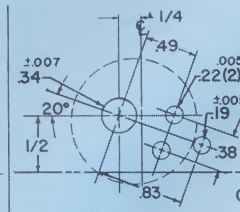
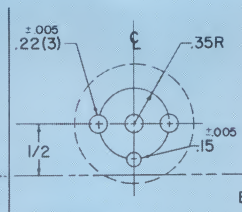


8 904B-Q Modules
with "L" type
brackets on bottom
and "R" type
mounting ring added
to top of Saucer Fan



Figure 9

Mixture of 901A-A
and 902A-J Modules
with "L" type
mounting brackets
on the fan end



L-8-32 -5/8 DEEP
M-10-32 -5/8 DEEP
N-1/4-28 -5/8 DEEP
P-3/8-24 -3/4 DEEP
Q-1/2-20 -7/8 DEEP
S-3/4-16 -1.00 DEEP
X-5/16-24-3/4 DEEP
(TAP DEPTH + 1/4-O)

* 1/4-20 TAP, 3/8 DEEP
MODEL 902 & 904

MODEL 901

NOTES:

1. Location of mounting groups on coolers to be within $\frac{1}{2}$ of true position.
2. Unless otherwise specified, tolerance on decimals $\pm .010$.
3. Mounting surface $\sqrt{64}$ and free of finish.
- *4. For electrical connection.

*4. For electrical connection.

If you wish WAKEFIELD to help with the design of your package, please phone or mail information per Sample Specification Form No. 16A, page 4.

Because the FCA-1000, 1100 and 1122 Packages are open structures and do not closely confine the airstream in a duct, the rating methods are different and, in some cases, more involved than the previously described Confined Airflow Series. The airstream stays closely confined to the finwork for about one fan diameter of package length. However, after this flow distance the airstream begins to increase in cross-sectional area with the air velocity in the finwork decreasing accordingly. This must be taken into account when analyzing a design.

The accessibility of these assemblies, their excellent performance, good hypot ratings, resistance to lint or dust stoppage, and general economy make them a most valuable addition to the WAKEFIELD line of Forced Convection Cooling Assemblies.

Here is an important factor to note. A long module will yield considerably lower case temperature rises per watt applied to it if the power is distributed along its length in several devices. This is in contrast to only one high power device mounted in the center of the module. The reason for this is that the cross-sectional area of metal in the ledge conducting heat to the finwork increases as a function of the number of devices mounted along it. Additionally, the average conduction distance from the devices to the finwork decreases as the devices are spread along the ledge.

Two sets of data are given for the FCA-1000, 1100 and 1122 Forced Convection Assemblies. The first set of data, Figure A and B, consists of both charts and curves. The curves show heat sink performance as a function of distance downstream from the fan. The chart shows separately the heating effect of upstream modules on downstream modules. The principle of superposition may be applied to obtain the total temperature rise of a given downstream module. The total temperature rise above fan inlet air temperature of this module is the sum of its own rise (θ from curves of Figure B times the dissipation on it) plus the induced rises caused by the other heated upstream modules.

The second set, shown for FCA-1000 in Table C, may be used to analyze groupings of equal length modules dissipating equal power. This data may be interpolated to estimate performance of packages made up of non-standard length modules.

If equal temperature rise of modules is required, then the module lengths may be weighted. Two FCA-1000 packages each designed with this purpose in mind is shown combined as a double unit in Figure 3, page 13. Thermal resistance of .185°C/w from case to ambient for each SCR was achieved with this unit.

The use of this data permits determination of performance when dissipation per semiconductor is not equal as when SCRs and rectifiers are used in the same assembly. It is again recommended that interpolation be used to gauge the performance of module lengths different from those rated in the curves and chart.

Several semiconductors may, of course, be mounted on one long heat sink so that the studs are electrically common. The thermal analysis of each semiconductor mounted on such a unit may be done by considering that a proportional fraction of the total module length is devoted to the cooling of each semiconductor. The length of the fraction devoted to each semiconductor then may be used to determine the temperature rise of each semiconductor as above.

As an example, an 18" long module with 3 devices equally spaced on it would yield substantially the same performance as 3 modules each 6" long. While back conduction will help to compensate against downstream heating, the amount of compensation is small and may be neglected. If equal device case temperature rises are required, then spacing should be arranged so that each device is in the center of an appropriate length of module.

HOW TO ORDER: The FCA-1000, 1100 and 1122 may be ordered by denoting the package model number, the module lengths starting at the fan end, and the mounting configuration on each module. Also state semiconductor center distances from end of each module if semiconductors are not centered or equally spaced.

EXAMPLE: FCA-1000 — 3.5W — 6W — 12WW designates an FCA-1000 Package consisting of 3 modules. Starting at the fan end they are 3½", 6" and 12" long respectively. The first two each have one "W" hole (0.765" dia.) in their centers and the 12" module has two "W" holes spaced 3 and 9 inches respectively from fan end of module.

FCA-1000 DATA FOR 3 DIFFERENT ASSEMBLIES

Numbers in table are the induced temperature rises measured at downstream modules (in °C) per watt applied to upstream modules. Power was applied successively to each module except last downstream module in successive tests.

FIGURE A

→ FCA-1000 3.5-3.5-3.5-3.5-3.5-3.5

	1st Module	2nd Module	3rd Module	4th Module	5th Module	6th Module
Test #1	Dissipating Power	.011	.007	.005	.003	.002
Test #2	0	Dissipating Power	.014	.010	.006	.004
Test #3	0	0	Dissipating Power	.016	.011	.008
Test #4	0	0	0	Dissipating Power	.019	.013
Test #5	0	0	0	0	Dissipating Power	.020
Fan outlet to center of module (inches)	2¾	6¾	10¾	14¾	18¾	22¾

→ FCA-1000 6.0-6.0-6.0-6.0

	1st Module	2nd Module	3rd Module	4th Module
Test #1	Dissipating Power	.012	.008	.005
Test #2	0	Dissipating Power	.014	.009
Test #3	0	0	Dissipating Power	.015
Fan outlet to center of module (inches)	3¾	10¾	16¾	23¾

→ FCA-1000 12-12

Test #1	Dissipating Power	.010
Fan outlet to center of module (inches)	6¾	19¾

FIGURE B

INSTRUMENTED MODULE LOADED WITH ONE SEMICONDUCTOR MOUNTED CENTRALLY, ALL OTHER MODULES WITHOUT SEMICONDUCTORS

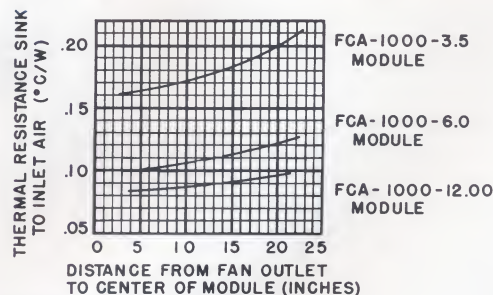
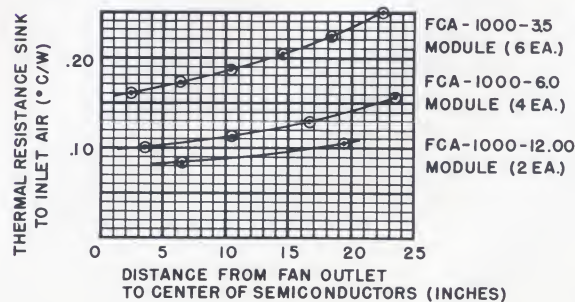


FIGURE C

ALL MODULES LOADED WITH CENTRALLY MTD. SEMICONDUCTORS DISSIPATING EQUAL POWER



The FCA-1000, the largest Cooling Assembly available today, has been developed to efficiently cool very large semiconductors such as high current rectifiers and SCRs. These are the 1 1/4" and 1 3/4" hex x 3/4" stud diameter rectifiers as well as the 3 1/4" square 650 amp Multi-Cell High Current Power Rectifiers.

The FCA-1000 utilizes the same extrusion as the WAKEFIELD Series MN King Size Heat Sinks. Wide fin spacing, in conjunction with the 570 cfm Rotron Caravel Fan, limits downstream air temperature rise to a small fraction of the permissible stud temperature rise. A 3 1/2" length of this heat sink will limit stud temperature rise to 50°C at a dissipation of 250w. Of all the cooling packages, the FCA-1000 has the lowest thermal impedance per station. The straight-line mounting of devices makes busing and connection of semiconductor pigtails to transformer breakouts relatively simple.

The package design can be varied to accommodate various circuit requirements. Six rectifiers can be mounted with electrically common studs on one long heat sink which will also serve as their commoning bus. Or, each of several semiconductors can be mounted on individual sinks so each is electrically isolated. Package lengths up to 48" are practical and two packages may be used together as shown in Figure B. In addition to standard semiconductor mounting configurations given in Table I, holes will be drilled to customer specifications. For additional performance, Type MN-2159 Heat Sink Inserts may be bolted to the heat sink or bonded with Delta Bond 152 Adhesive. Extrusion and Insert are seen in Figure 2.

FANS:

Standard: Rotron Caravel, Type CL2T2, 115v, 50/60 cps, single phase, with thermal protector and terminal block.

Optional: Rotron Caravel, Type CL3T2, 230v, 50/60 cps, single phase, available on special order.

Rotron Model HF fan is available with special windings for 50-400 cps, 115-440v, either 1 or 3-phase, with airflow outputs up to 1,000 cfm at 60 cps or 1650 cfm at 400 cps. However, it should be noted that these high performance units do not operate as quietly as the Caravel.

MOUNTING ACCOMMODATIONS FOR SEMICONDUCTORS ON MODULES IN FCA-1000, 1100 and 1122.

FCA Series No.	A	B	C	D	E	F	G	H	J	K	R	T	U	V	W	Y	Z	A1	B1	C1	D1	E1	F1	J1	L1
1000																12	12	12	19	20	21				
1100									12	12						12									
1122	2	5	7	10	12	12	12	12	12				12	15	16	17	12				22	23	24	27	28

"A" T0-3 2	"B" T0-36 5	"C" SP-33 MT-1 7	"D" T0-53 10
"E" T0-66 23	"F" T0-56 24	"G" T0-3 27	"H" T0-3 28
"I" T0-3 2	"J" T0-36 5	"K" SP-33 MT-1 7	"L" T0-53 10
"M" T0-3 2	"N" T0-36 5	"O" SP-33 MT-1 7	"P" T0-53 10
"Q" T0-3 2	"R" T0-36 5	"S" SP-33 MT-1 7	"T" T0-53 10
"U" T0-3 2	"V" T0-36 5	"W" SP-33 MT-1 7	"X" T0-53 10
"Y" T0-3 2	"Z" T0-36 5	"AA" SP-33 MT-1 7	"AB" T0-53 10
"AC" T0-3 2	"AD" T0-36 5	"AE" SP-33 MT-1 7	"AF" T0-53 10
"AG" T0-3 2	"AH" T0-36 5	"AI" SP-33 MT-1 7	"AJ" T0-53 10
"AK" T0-3 2	"AL" T0-36 5	"AM" SP-33 MT-1 7	"AN" T0-53 10
"AO" T0-3 2	"AP" T0-36 5	"AQ" SP-33 MT-1 7	"AR" T0-53 10
"AS" T0-3 2	"AT" T0-36 5	"AU" SP-33 MT-1 7	"AV" T0-53 10
"AW" T0-3 2	"AX" T0-36 5	"AV" SP-33 MT-1 7	"BU" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
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"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10
"BW" T0-3 2	"BW" T0-36 5	"BW" SP-33 MT-1 7	"BV" T0-53 10

The FCA-1100 Cooling Package is a smaller version of the FCA-1000. It utilizes the WN-1245 Heat Sink Extrusion which accepts rectifiers and SCR cases up to 1 1/4" hex x 3/4" stud. Using the long-life, economical Deltaire 40 Fan, this package is useful for groups of semiconductors with total dissipation up to 1 or 2 kilowatts, depending upon ambient and the semiconductor types.

The heat sinks may be used as a commoning bus for several devices or each device may be mounted on its own isolated heat sink. Hypot ratings up to 5kv a-c are easily achieved with the FCA-1100 Package. However, 1/4" module-to-module spacing with a nominal 3kv hypot rating is standard.

Total package lengths up to 24" are practical. The glass reinforced plastic angle used for mechanically supporting the module is extremely rugged and withstands indefinitely the maximum operating temperature to which silicon devices subject it.

FANS: See listing of 115v 60 cps Fans on page 9.

MATERIAL, FINISH, END PLATES, HYPOT and MOUNTING CONFIGURATIONS, see page 13.

BRACKETS: Glass fiber reinforced plastic per MIL-C-8013.

RIVETS: Aluminum, 5052.

FCA-1100 DATA FOR 3 DIFFERENT ASSEMBLIES

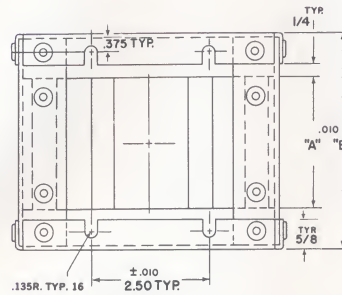
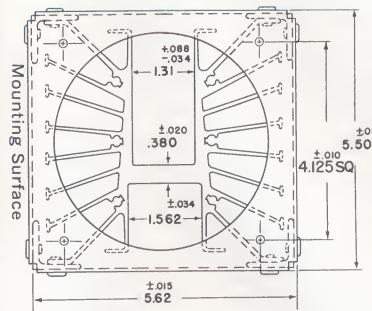
Numbers in table are the induced temperature rises measured at downstream modules (in °C) per watt applied to upstream modules. Power was applied successively to each module except last downstream module in successive tests.

Figure A

FCA-1100 2.75-2.75-2.75-2.75-2.75-2.75						
	1st Module	2nd Module	3rd Module	4th Module	5th Module	6th Module
Test #1	Dissipating Power	.040	.035	.032	.029	.027
Test #2	0	Dissipating Power	.050	.040	.035	.031
Test #3	0	0	Dissipating Power	.057	.043	.036
Test #4	0	0	0	Dissipating Power	.065	.045
Test #5	0	0	0	0	Dissipating Power	.075
Fan outlet to center of module (inches)	2 3/8	5 3/8	8 3/8	11 3/8	14 3/8	17 3/8

FCA-1100 5.75-5.75-5.75			
	1st Module	2nd Module	3rd Module
Test #1	Dissipating Power	.030	.025
Test #2	0	Dissipating Power	.035
Fan outlet to center of module (inches)	3 3/4	9 3/4	15 3/4

FCA-1100 11.75-11.75		
Test #1	Dissipating Power	.022
Fan outlet to center of module (inches)	6 3/4	12 3/4



MODEL NO.	DIM. "A"	DIM. "B"
FCA-1100-2.75	2.75	4.50
FCA-1100-5.75	5.75	7.50
FCA-1100-11.75	11.75	13.50

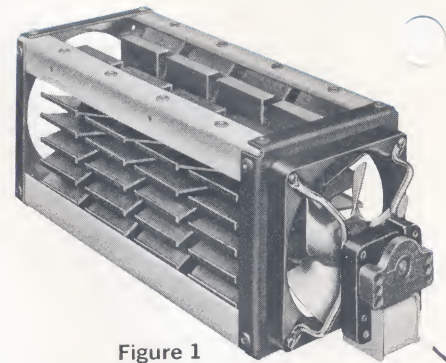


Figure 1

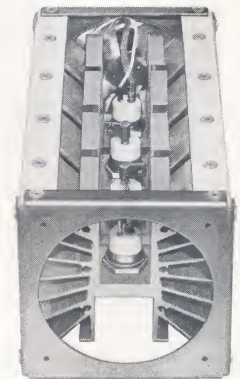


Figure 2

Figure B

INSTRUMENTED MODULE LOADED WITH ONE SEMICONDUCTOR MOUNTED CENTRALLY, ALL OTHER MODULES WITHOUT SEMICONDUCTORS

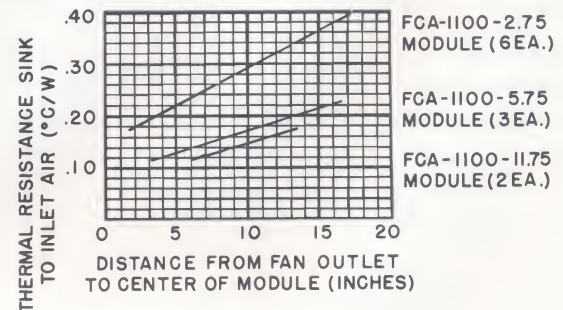
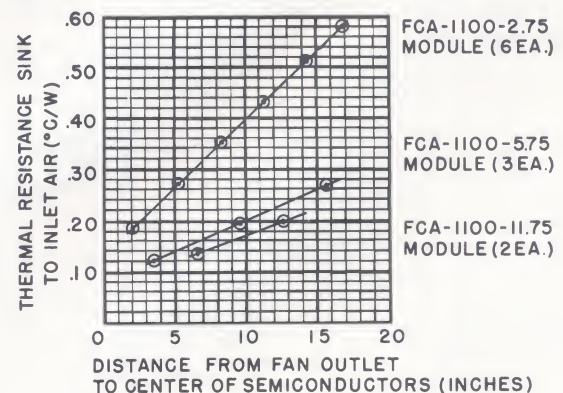


Figure C

ALL MODULES LOADED WITH CENTRALLY MTD. SEMICONDUCTORS DISSIPATING EQUAL POWER



This package fits within the same outline dimensions as the FCA-1100. However, the one larger heat sink extrusion in the FCA-1100 is now replaced by two smaller extrusions mounted side-by-side in front of a Deltaire 40 Fan to form the FCA-1122 Package. The FCA-1122 modules are compatible with and may be mounted in an FCA-1100 Package with one or more FCA-1100 modules.

The FCA-1122 modules accept power transistors such as T0-3 and T0-36 as well as hex sizes up to $1\frac{1}{16}$ ". Thermal resistance, sink to ambient, as low as $0.3^{\circ}\text{C}/\text{w}$ may be achieved near the fan end on a $5\frac{3}{4}$ " long module. But it should be noted that downstream heating and air loss will increase the thermal resistance of downstream modules well above this value.

The FCA-1122 is particularly useful for cooling a few components where thermal resistance per device must be lower than that which can be achieved on FCA-800A or 820A modules.

To order, describe modules in right and left side of package, as viewed from fan end, separately.

FANS: See listing of 115v 60 cps Fans on page 9.

MATERIAL, FINISH, END PLATES, TENZ NUTS (AND SCREWS), HYPOT and MOUNTING CONFIGURATIONS, see page 13.

BRACKETS: Glass fiber reinforced plastic per MIL-C-8013.

FCA-1122 DATA FOR 3 DIFFERENT ASSEMBLIES

* Numbers in table are the induced temperature rises measured at downstream modules (in $^{\circ}\text{C}$) per watt applied to upstream modules. Power was applied successively to each module in left half of package except last downstream module in successive tests.

Figure A

→ FCA-1122 Left half 2.75-2.75-2.75-2.75-2.75-2.75
Right half same as left half

	1st Module	2nd Module	3rd Module	4th Module	5th Module	6th Module
Test #1	Dissipating Power	.058	.046	.035	.025	.019
Test #2	0	Dissipating Power	.080	.065	.050	.040
Test #3	0	0	Dissipating Power	.095	.077	.064
Test #4	0	0	0	Dissipating Power	.115	.097
Test #5	0	0	0	0	Dissipating Power	.140
Fan outlet to center of module (inches)	2 $\frac{1}{4}$	5 $\frac{1}{4}$	8 $\frac{1}{4}$	11 $\frac{1}{4}$	14 $\frac{1}{4}$	17 $\frac{1}{4}$

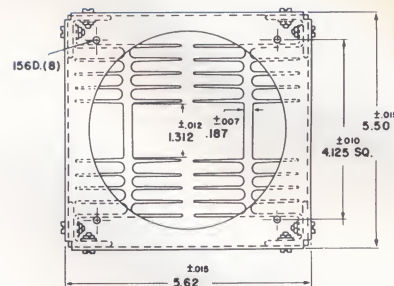
→ FCA-1122 Left half 5.75-5.75-5.75
Right half same as left half

	1st Module	2nd Module	3rd Module
Test #1	Dissipating Power	.050	.035
Test #2	0	Dissipating Power	.070
Fan outlet to center of module (inches)	3 $\frac{3}{4}$	9 $\frac{5}{8}$	15 $\frac{5}{8}$

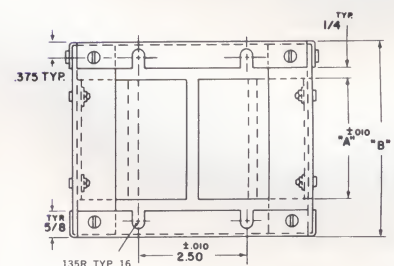
→ FCA-1122 Left half 11.75-11.75
Right half same as left half

Test #1	Dissipating Power	
		.04
Fan outlet to center of module (inches)	6 $\frac{3}{4}$	12 $\frac{3}{4}$

* Test data for 1122 assemblies is for only one of the two rows of



Mounting Surface



MODEL NO.	DIM. "A"	DIM. "B"
FCA-1122-2.75	2.75	4.50
FCA-1122-5.75	5.75	7.50
FCA-1122-11.75	11.75	13.50

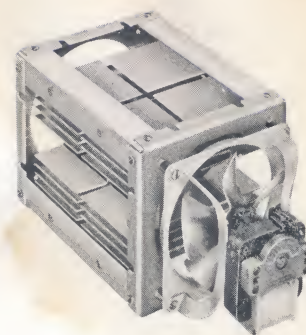


Figure 1

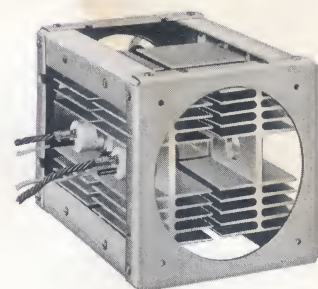


Figure 2

Figure B

INSTRUMENTED MODULE LOADED WITH ONE SEMICONDUCTOR MOUNTED CENTRALLY, ALL OTHER MODULES WITHOUT SEMICONDUCTORS

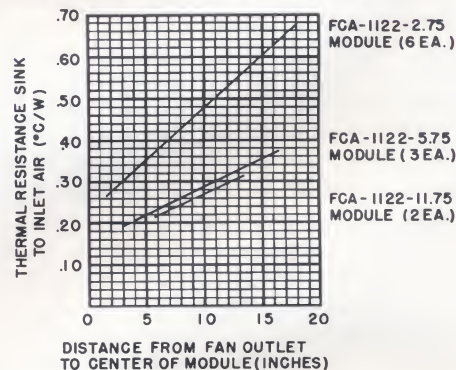
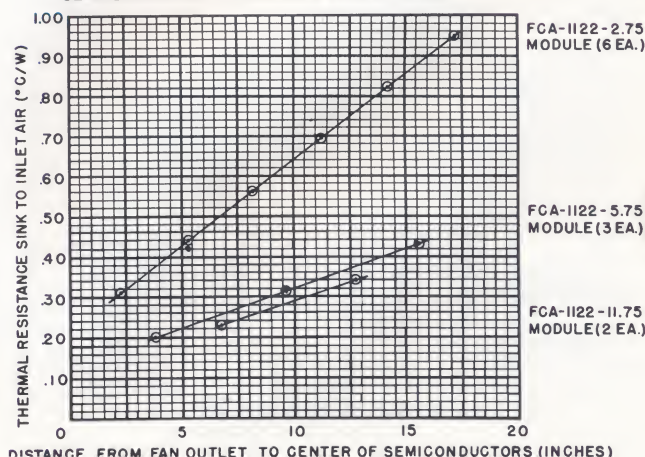


Figure C

ALL MODULES LOADED WITH CENTRALLY MTD. SEMICONDUCTORS DISSIPATING EQUAL POWER



...dissipation of a few hundred watts, the FCA-1200 with fan blowing perpendicularly against the finned base should be considered. This orientation of the fan to heat sink is most effective since the interruption in the direction of air flow causes much surface washing and turbulence.

The FCA-1200 configuration was originally developed as a heat exchanger for cooling the hot side of thermoelectric modules as shown in Figure A. However, Delta Coate 151, in conjunction with Delta Bond 152 Thermal Adhesive, has made practical the use of these heat sinks in the cooling of electrically isolated semiconductor mounting blocks. Also, the new Series 254 Thermal Retainers can be bonded to the FCA-1200 for mounting 0-5 transistors. See Figure 3.

A clamped assembly technique can also be used by screwing or clamping the device to be cooled to the heat sink using insulating shoulder washers. This permits replacement of faulty modules and other components simply by removing the assembly screws. It is recommended in this case that Type 120 Thermal Joint Compound be applied between the part being mounted and the Delta Coate 151. The clamped assembly can accommodate differential expansion to minimize mechanical stresses if different materials are being used.

The Type 151 Coating is applied to an area considerably larger than the base area of the devices or blocks being mounted. This gives a long creepage path and the high dielectric insulating film provides good electrical insulation yet also provides high thermal conductivity. Mounting blocks or other items to be cooled may then be bonded in position with Type 152 Adhesive, either by the user or by WAKEFIELD ENGINEERING. Hypot ratings of 2kv a-c are readily attained.

Types 1205 and 1208 Cooling Packages are available with a special version of the Deltaire 40 Fan for long life, high quality and economy. Each type is provided with one of three heat sink constructions: AE aluminum extrusion shown in Figure 1, AS aluminum staked fin shown in Figures 2 and 3, and CS copper soldered fin shown in Figure 6. An aluminum mounting block with a 2" x 2" bonding area of 4 in.², seen in Figure 6, has an interface thermal resistance to the heat sink (across the film connecting) of only .075°C/w. These heat sinks have resistances ranging between .06 and .25°C/w depending on the particular sink type and the distribution of the load on them.

The CS type heat sinks can be easily fabricated with voids in the fin work to permit feed-through of transistor terminals or bolting of stud type semiconductors through the plates. The AS and AE types can also be furnished with areas relieved of fins. The AE type, while giving higher thermal resistance than the AS or CS types, is the most economical. It also will operate for a longer time in dusty environments without linting up. However, the AS version was operated 24 hours a day, 7 days a week, for 16 months without cleaning. A reduction in thermal performance of only 30% was measured.

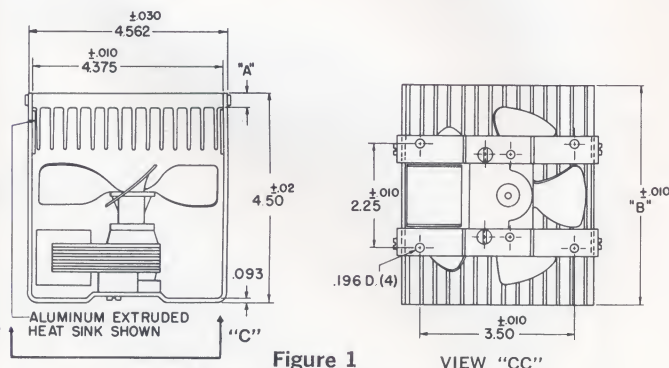


Figure 1
Model AE heat sink with
"U" type fan bracket

Figure 2
Model AE heat sink
with "U" type
fan bracket

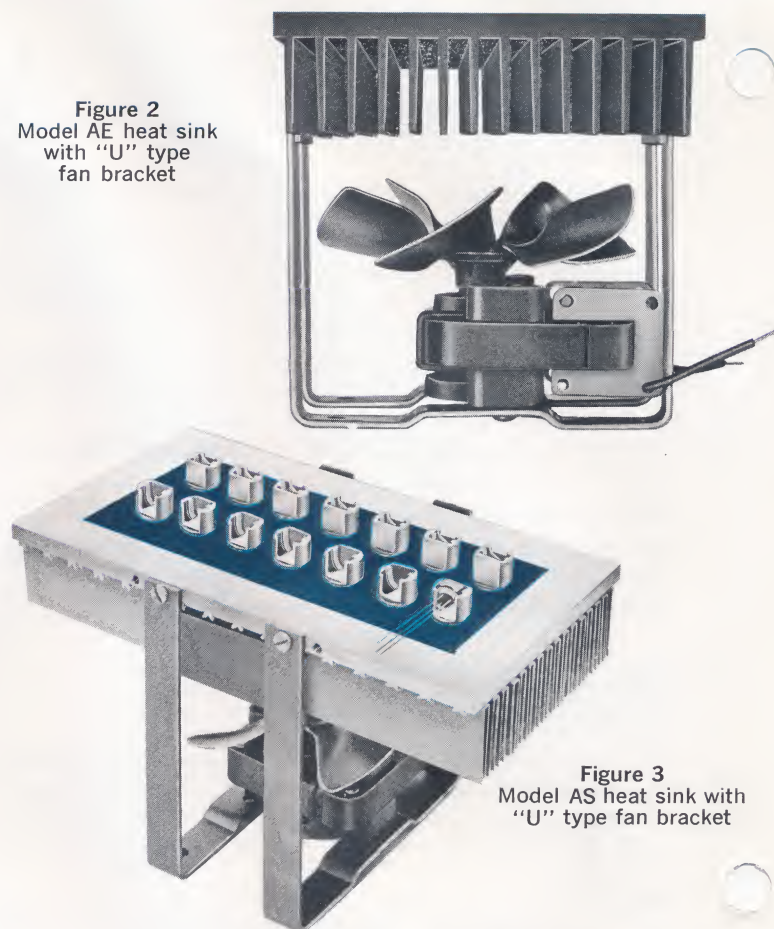


Figure 3
Model AS heat sink with
"U" type fan bracket

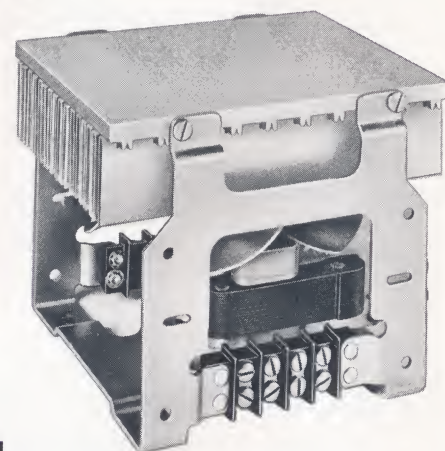


Figure 4
Model AS heat sink with "H" type fan bracket

Fan Sink Assembly Type	Thermal Resistance Sink to Ambient		Dimensions	
	1" dia. load in center of base	2" x 5" load (Central with 5" dim parallel to fins)	A ± 1/64"	B ± 1/8"
1205AE	.30	.17°C/w	3/32	5
1208AE	.19	.13°C/w	3/32	8
1205AS	.20	.14°C/w	3/32	5
1215AS	.18	.12°C/w	3/8	5
1208AS	.16	.10°C/w	3/32	8
1205CS	.15	.08°C/w	1 1/64	5
1208CS	.12	.06°C/w	1 1/64	8

A = sink length; B = base thickness.

The flat mounting surface of all units is guaranteed flat within .001 inches/inch.

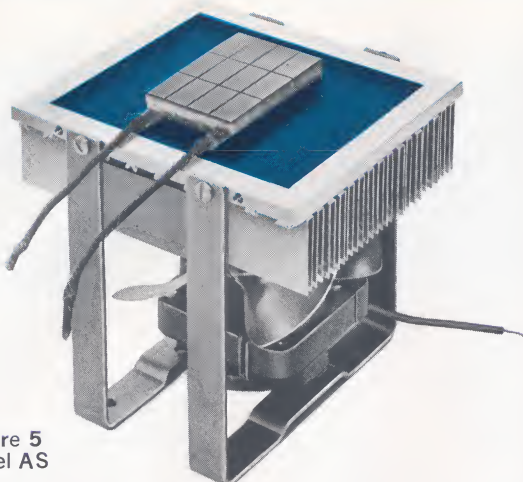


Figure 5
Model AS

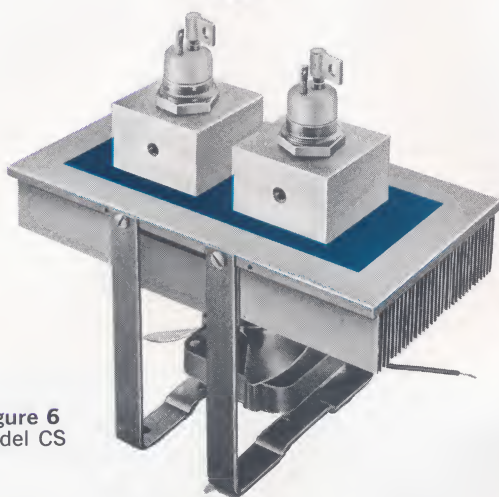


Figure 6
Model CS

Type 151 superior isolating film is used where both electrical isolation and good thermal conduction are required. Parts or mounting blocks to be cooled may be cemented with Delta Bond 152 Thermally Conductive Adhesive to heat sinks coated with Type 151. The clamped assembly technique for thermoelectric modules, where coating and Type 120 Thermal Joint Compound are both used, permits replacement of faulty modules and other components simply by removing the assembly screws. Table I is included to aid design engineers in selecting clamping hardware with acceptably small heat leak level. It shows the thermal resistivities of various screws in °C/watt/inch of length.

WAKEFIELD ENGINEERING will supply heat sinks or cold plates precoated with Delta Coate 151 or will coat customer parts to specifications. A .005 ±.001 coating is suggested for most applications, although both thinner and thicker coatings are available.

ADVANTAGES OF TYPE 151 COATING

- High dielectric strength — 750 v/mil.
- Low thermal resistivity — 47°C in./w = ρ
- Maintains physical and electrical properties at temperatures up to 200°C and as low as a few degrees Kelvin.
- Excellent adhesion to both copper and anodized or irridited aluminum.
- Minimum moisture absorption — 0.10%.
- High volume resistivity — 10^{16} ohm-cm at room temperature.
- Excellent mechanical strength — 2,100 psi bond shear strength, 1" overlap at room temperature.

ADVANTAGES OF TYPE 151 OVER HARDCOATING

- Economical — less than one-half the cost of hardcoat in heat sink applications.
- Eliminates etching and electrolysis which are present with anodic coating.
- Permits the use of copper cold plates and heat sinks with their excellent thermal properties.
- Provides high voltage isolation (i.e., 0.006" coating yields 4500v dielectric strength) for such applications as water cooled semiconductor heat sink assemblies.
- Parts or mounting blocks to be cooled may be cemented with Delta Bond 152 Adhesive to heat sinks coated with Type 151

METHOD OF CALCULATION:

In order to calculate the temperature drop across the coating, the following formula may be applied:

$$\Delta T = \frac{\rho t P}{A}$$

where ΔT = temp. drop across coating in °C.

ρ = specific thermal resistivity of #151 coating = 47°C inches/watt.

t = coating thickness in inches.

P = rate of heat flow in watts.

A = area of coating in square inches.

For Delta #120 Joint Compound ρ = 56°C inches/watt, and for most assemblies an average thickness as small as .0005 inches can be achieved. The equation above may also be used to calculate the thermal drop across the joint compound which in most applications will be negligible. ρ values for other materials are listed in Table 2.

TYPICAL THERMOELECTRIC APPLICATION EXAMPLE:

A thermoelectric module with an area of 4 square inches presents at its hot side 40 watts to be dissipated. What will be the thermal drop across a film of #151 coating .0025 inches thick applied to the heat sink?

Solution:

$$\Delta T = \frac{\rho t P}{A} = \frac{47 (.0025) (40)}{4} = 1.18^\circ\text{C}$$

A .0025" coating of Delta Coate #151 will cause a temperature differential of only 1.18°C between hot side of module and heat sink.

Note: A much smaller temperature differential will occur at the cold side, since the pumped power is generally only a fraction of the I²R losses.

TABLE I

Thermal Resistivities of Screws in °C/watt/inch of length			
Size	Steel Screws	Stainless Steel Screws	Nylon Screws
0-80	410	1090	72,000
2-56	200	540	35,600
4-40	120	320	21,200
6-32	80	210	14,000
8-32	54	140	9,400
10-32	42	110	7,400
¼-20	24	64	4,200

TABLE 2 VALUES FOR ρ (°C IN/WATT)

Still Air	1200
Silicone grease	204
Mylar film	236
Mica	66
Type 120 Joint Compound	56
Type 151 Delta Coate	47
Type 152 Delta Bond	47
Type 153 Delta Cast	47
Aluminum	0.19
Copper	0.10

Power dissipation in very high current rectification and regulation systems often reaches levels which make Liquid Cooled Plates more desirable than the more conventional forced air systems. Typical examples of such requirements are plating systems, particle accelerator magnet regulators, high density computer packages, etc. The WAKEFIELD Series LCP-10 Liquid Cooled Plates were developed for such systems.

The LCP-10, LCP-11 and LCP-12 aluminum cold plates shown in Figures 1, 2 and 3 can be used to mount most types of power transistors, rectifiers and controlled rectifiers. Mounting holes may be provided to customer specifications. These Liquid Cooled Plates may be considered an integral portion of the high current bus work and they may be run at higher current densities than open uncooled busing. Electrical isolation of individual sections can be achieved by using plastic or rubber hose for interconnection to the coolant supply.

A stream of water flowing at a rate of 1 gal./min. will rise 4°C for each kw applied to it. Silicone and other similar fluids will have temperature rises about twice as great. For loads distributed on a cold plate so that the power level does not exceed 100w/linear inch for LCP-10 or LCP-11, or 200w/linear inch for the LCP-12 or LCP-20, the temperature rise of the cold plate will be approximately twice the temperature rise of water thru it. Both rises are referenced to inlet fluid temperature. Either aluminum or copper tubing with 3/8" O.D. x 1/32" wall may be specified. Aluminum tubing is supplied unless copper is specified. Channel legs, originally upright, are rolled over the tubing after Delta Bond 152 Adhesive has been applied to seal out moisture and corrosive agents, add mechanical strength and provide a good thermal path. The use of drawn tubing with standard plumbing connectors assures a leakproof system which, if necessary, will stand high pressures.

Although lengths are specified in 6" increments up to 2 feet, any length Liquid Cooled Plate can be provided up to 6 ft. long.

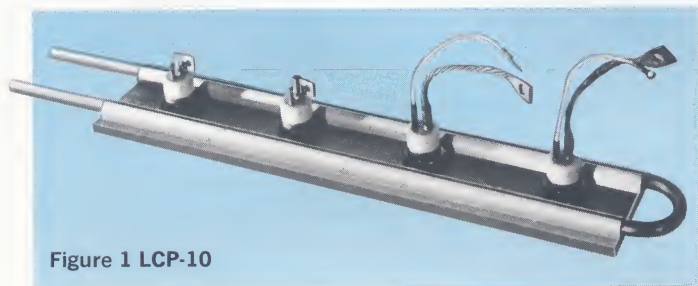
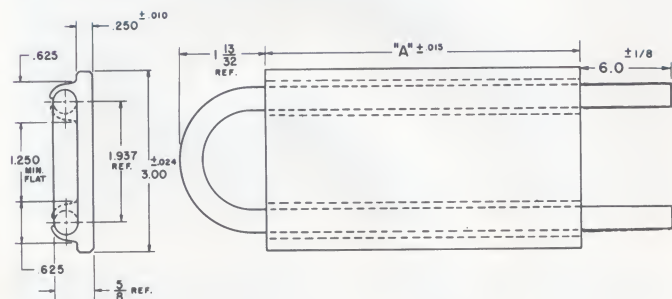


Figure 1 LCP-10



Model No.	Dim. "A"
LCP-10- 6.0	6.0
LCP-10-12.0	12.0
LCP-10-18.0	18.0
LCP-10-24.0	24.0

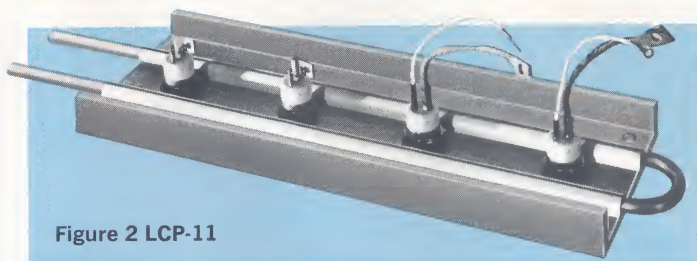
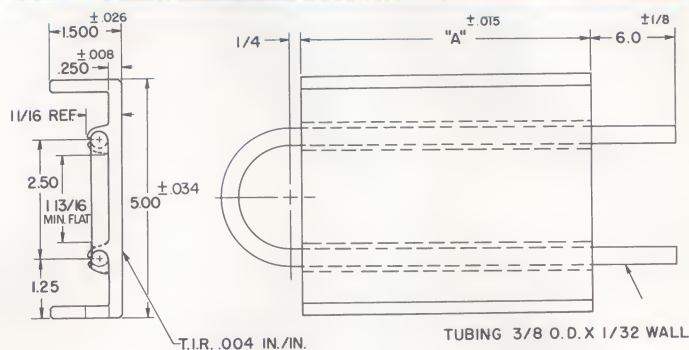


Figure 2 LCP-11



Model No.	Dim. "A"
LCP-11- 6.0	6.0
LCP-11-12.0	12.0
LCP-11-18.0	18.0
LCP-11-24.0	24.0

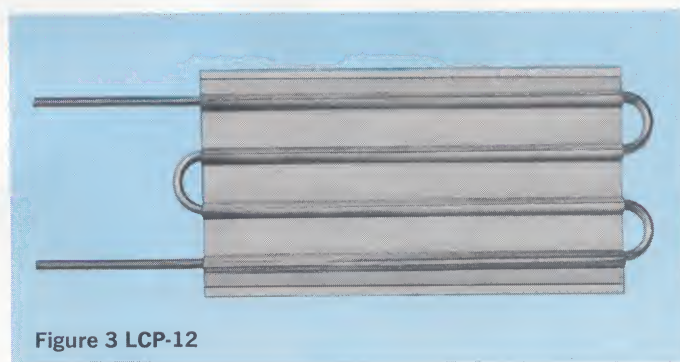
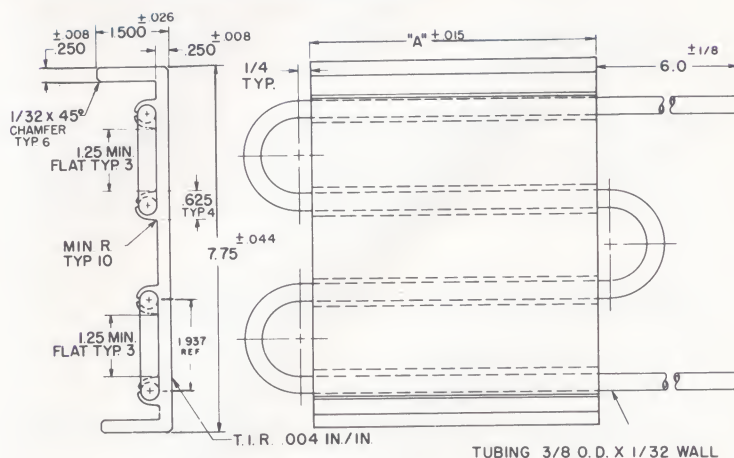


Figure 3 LCP-12



Model No.	Dim. "A"
LCP-12- 6.0	6.0
LCP-12-12.0	12.0
LCP-12-18.0	18.0
LCP-12-24.0	24.0

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If it is desired to make up a large flat surface, LCP-11 and LCP-12 may be edge bolted into panels such as shown in Figure 4.

Surfaces can be furnished coated with Delta Coate 151 described on page 17. Also, semiconductor mounting blocks can be bonded to this surface with Delta Bond 152 Thermally Conductive Adhesive. (See page 15 of Catalog No. 1966.) Hypot rating between the block and the LCP unit of 3000v a-c is easily achieved with a coating plus a bond film thickness of .007". Then the thermal impedance between a 2" x 2" block and the LCP unit is only .085°C/w.

SERIES LCP-20

The LCP-20 offers two flat sides to which modules may be affixed when modular circuitry is to be water cooled.

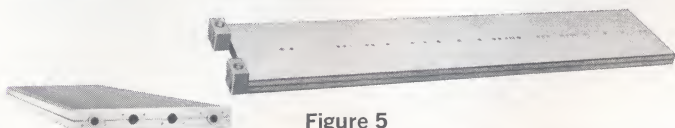


Figure 5

The version of the LCP-20 shown in Figure 5 has four runs of $\frac{3}{8}$ " O.D. copper tubing imbedded between two $\frac{3}{16}$ " thick aluminum plates. These plates are tied together by 8 runs of interlocking, opposed, angled tongue-and-grooves. The return loops of the unit in Figure 5 are contained in milled grooves between the plates. This feature protects the tubing loops. However, these LCP-20 units can be furnished with loops exposed, and at lower cost.

Figures 6 and 7: An Electronic Amplifier Module for a 3500 Ampere Extraction Magnet Modulator utilizes 16 special version LCP-12 units. It is built by Princeton-Pennsylvania Accelerator, Princeton University.

Each LCP unit cools a total of 144 transistors: 108 final output transistors driven by 12 driver transistors. Also 24 bias transistors permit the output current to go negative; i.e., flow into the output terminals in the conventional sense. Each 52" LCP-12 version has three columns of 48 transistors each, plus extra mounting and feedthrough holes. There is 2" free area beyond the edges of the last transistors on both ends and 18" of tubing length extended beyond the end prior to assembly.

Figure 6 shows a partially assembled module in the foreground and a completed module in the background with cover removed. The panel carrying the fuses is at a right angle to the Liquid Cooled Plate. The location of the printed circuit boards, fitting into special slots in the extrusion, makes for a very compact and densely packed design. A heavy copper bus runs up the back of the module to carry the output current. Four of these modules fit side-by-side in one 19" wide rack as shown in Figure 7.

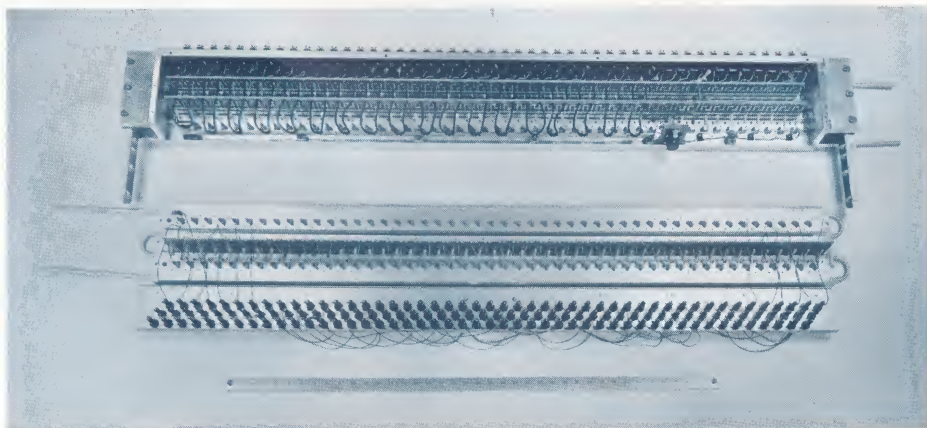


Figure 6

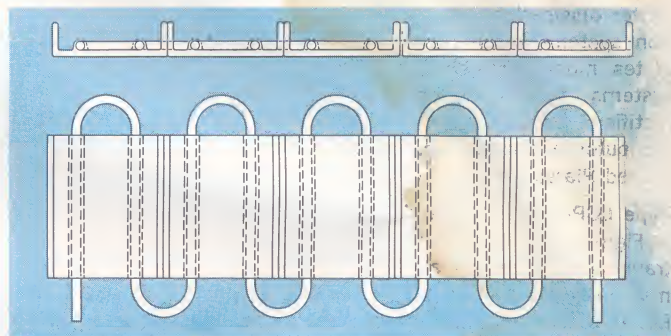


Figure 4

MATERIAL: 6063-T5 aluminum.

FINISH: No finish unless specified.

TUBING: Aluminum alloy 5050-0 or copper. If not specified, 5050-0 aluminum will be supplied.

FITTINGS: All LCP units are available with a working length of exposed tubing for connection into plumbing using either couplings or elbows, normally $\frac{1}{4}$ " pipe nominal. Compression, flair, brazed or sweat fittings can be installed. (Fittings on unit in Figure 5 are specials.) Manifolding of multiple units will also be done to customer requirements. See Figure 4.

HOW TO ORDER: Specify how many, LCP unit number, type of tubing (aluminum or copper), length of LCP, length of free tubing for connections or type of fitting, and sketch of hole pattern if WAKEFIELD is to provide. For units assembled together in panels, provide drawing. If loop is to be within the LCP rather than exposed, specify this. EXAMPLE: 10 · LCP-12-18.00 with 6" of free tubing. Drill hole pattern per attached drawing.

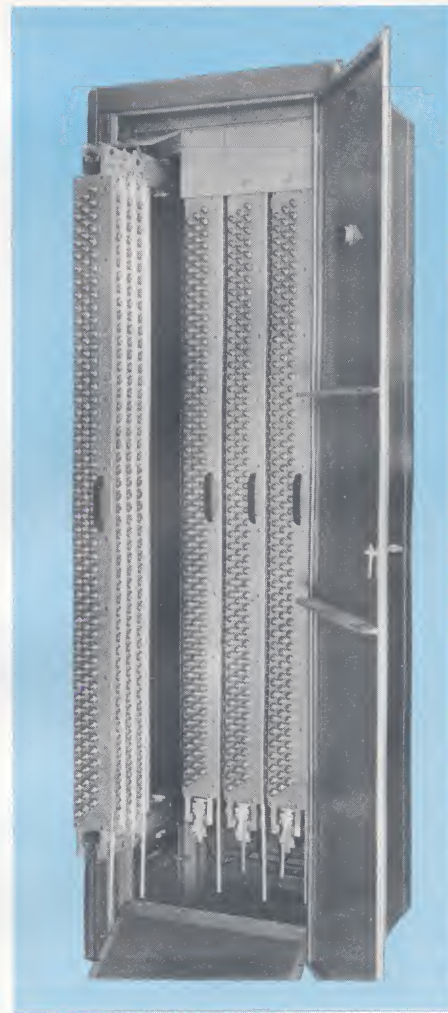


Figure 7

Cooling Products Specially Engineered to Custom Requirements

...ing configurations shown with previous pages are supplied without. However, special module lengths and represent a large portion of WAKEFIELD production, and these are accomplished with the conomical methods. Engineering assistance, thermal design, mechanical design and general cost able for specials.

...g electronic components and equipment is our business. Semiconductors are the most temperature sensitive in this equipment and hence the most often cooled, we also well-versed in the cooling of klystrons, magnetrons, traveling wave tubes, high power resistors, high power triodes, complete cabinets, etc. Both air and liquid methods are employed. Inquiries are welcomed.

Marking and stenciling of key components, such as "Q" and "OR" numbers, can be provided to customer specifications. Electrical busing, tie-buses, etc., also are designed and built into systems.

Figure A: Special extrusions and hole patterns fabricated to customer requirements. Some of the extrusions shown are standard Series FSE shown on page 22. Finishes are to customer specifications.

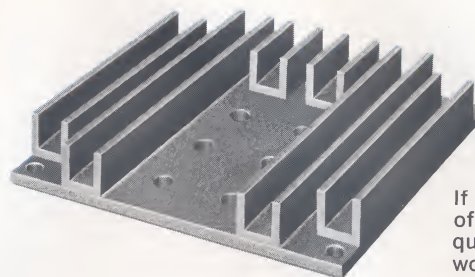
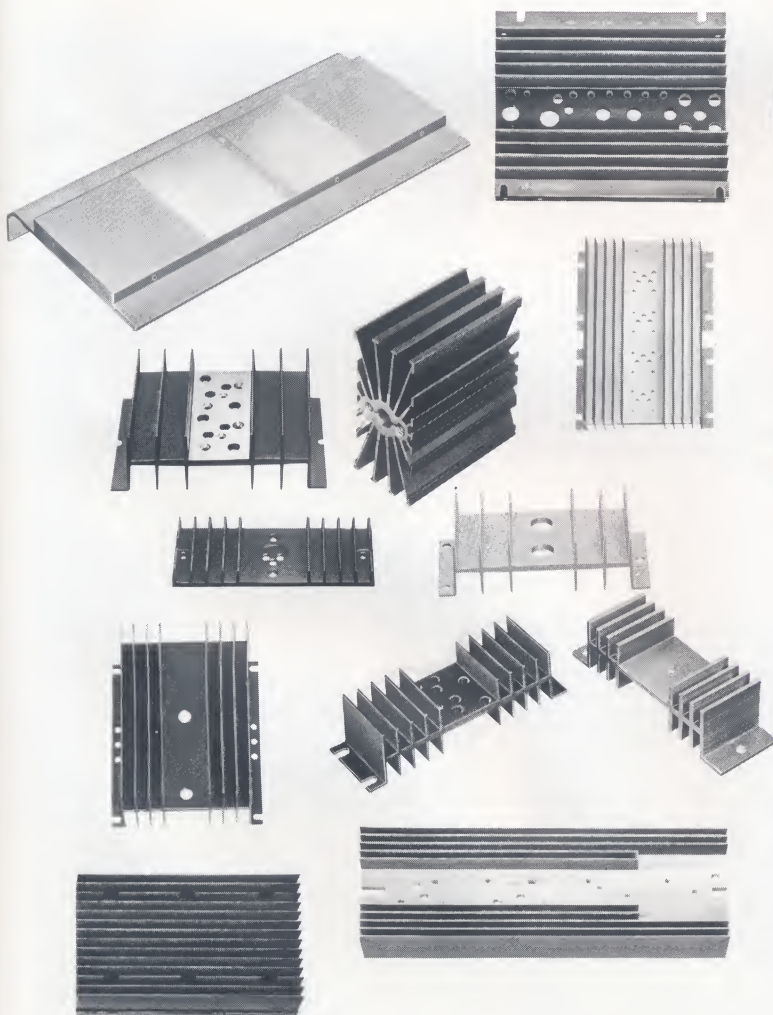


Figure B: U-fins bonded to base plate with Delta Bond 152 for a more economical end product than a dip-brazed unit. If production quantities of this design are required, an extrusion die would become practical.

Figure C: U-fin pairs affixed to a self-ripping base plate extrusion. This technique permits assemblies of unlimited width to be fabricated. Delta Coate 151 can be applied to the base plate on these aluminum units.

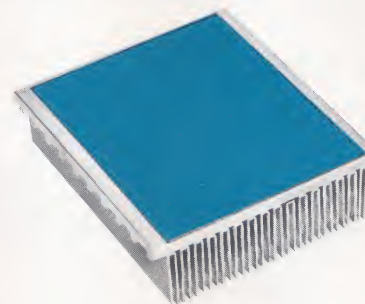


Figure D: Copper heat sinks assembled with soft solder. These coolers typically yield the greatest thermal performance per unit volume of space occupied. Mounting section may be coated with Delta Coate 151 on some units.

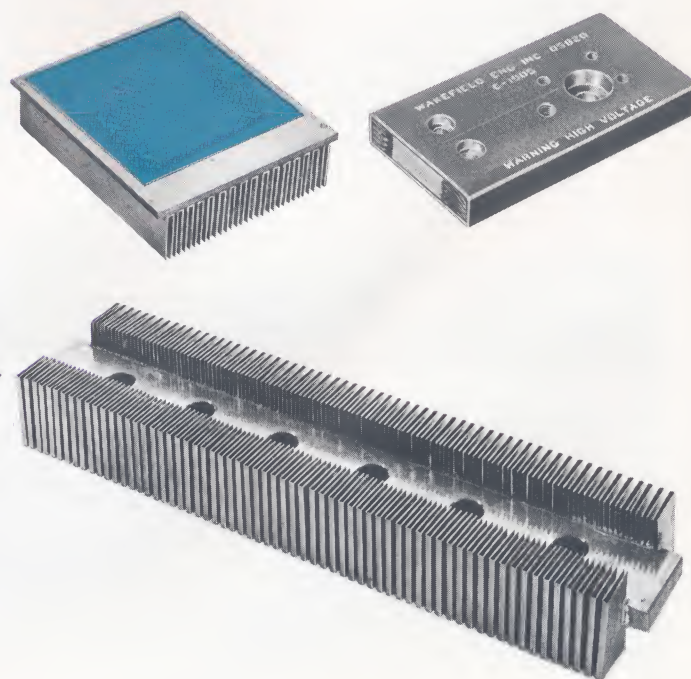




Figure E: Example of a high production formed brass clip for electrostatic shielding epoxy flat pack field effect transistors. Note single and double units with and without grounding tab, shown actual size.

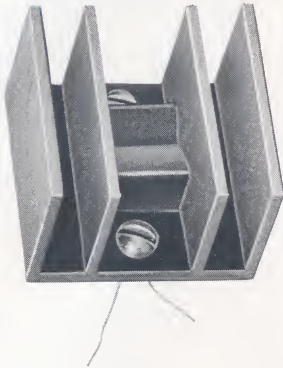


Figure F: Retaining clip and special extrusion for a TO-5 transistor. High performance and form factor were the important considerations.



Figure G: Special combination retainer and sink for TO-5 case style. Allows separate mountings of Cinch socket and transistor.



Figure H: Shrouded finned copper block for dense packaging in airborne equipment.



Figure I: Short fins are extruded with the plate to provide interface for bonding tall fin channels to plate with Delta Bond 152 Thermally Conductive Adhesive. This cooler is for a thermoelectric generator and is approximately 7" x 10" x 6" high.

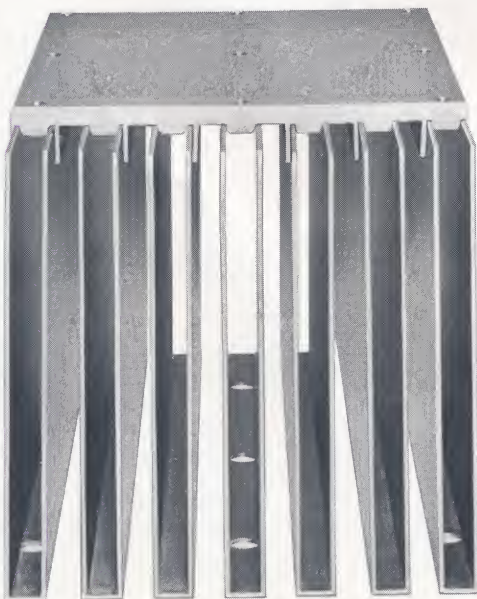


Figure J: Aluminum heat sink with two Delta Bond heat sinks attached. Approximate

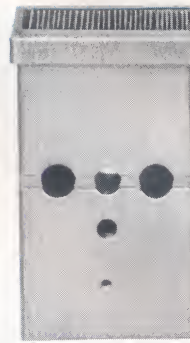


Figure K: Standard WAKEFIELD Heat Sinks can be developed into specialized designs. Using Type NC-303 Heat Sinks and the Series 300 Stacking Hardware Kit, a rectifier stack is assembled.

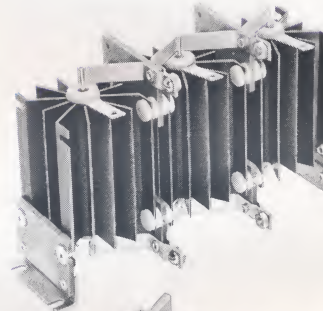


Figure L: Special terminal boards added to a standard FCA-820 Package.

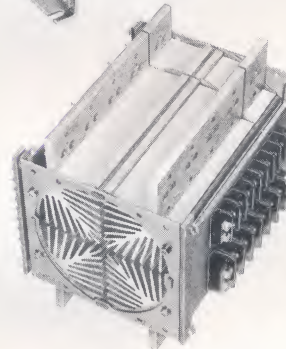
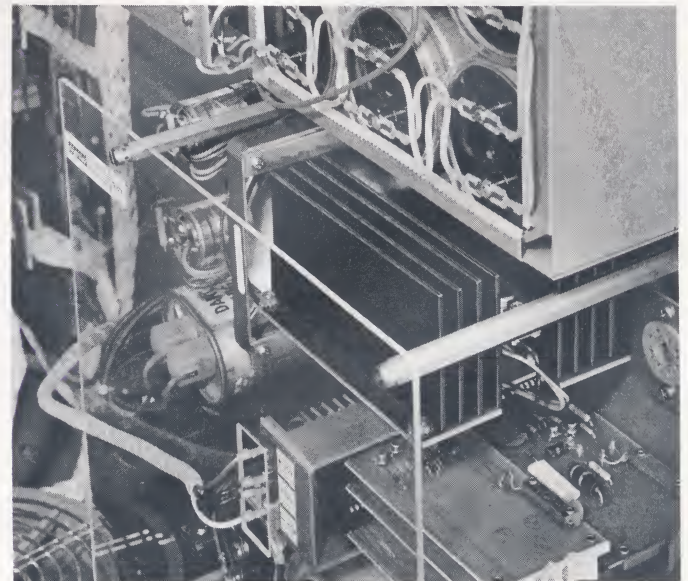


Figure M: Digital Equipment Corp., in their PDP-7 computer, uses a NC-423 Heat Sink in a forced convection application with a standard Howard Cyclohm Fan to cool two transistors in their No. 739 Power Supply.

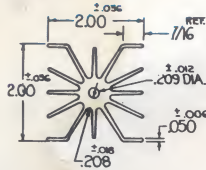


Quotation requests are invited for Heat Sinks fabricated from the Extrusions shown below. WAKEFIELD stocks these in 6 ft. lengths. Any Extrusion is available for prototype requirements in 2, 4 or 6 ft. $\pm 1/4$ " lengths, with shipment usually made within 24 hours after receipt of order. Parts fabricated from these

Extrusions to your drawing can generally be shipped one to two weeks after getting your order. For prices, contact your WAKEFIELD Representative. The Distributor Products Catalog lists standard Heat Sink Extrusions on page 2.

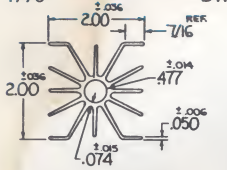
WT./FT. .929

DWG. A-1290-P2



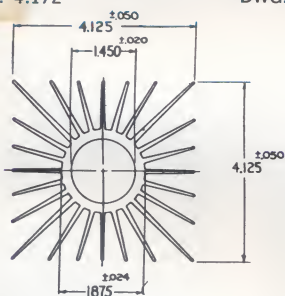
WT./FT. .775

DWG. A-1290-P3



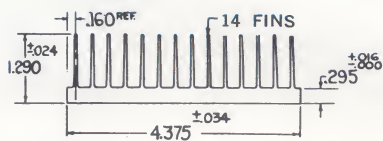
WT./FT. 4.172

DWG. B-1010



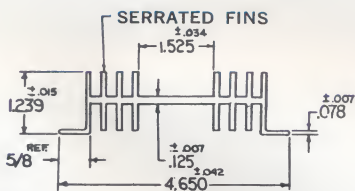
WT./FT. 2.630

DWG. A-1527



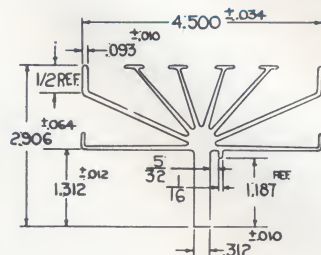
WT./FT. 1.480

DWG. A-1662



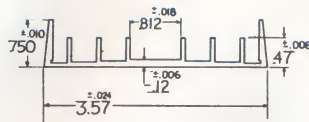
WT./FT. 2.156

DWG. B-1753



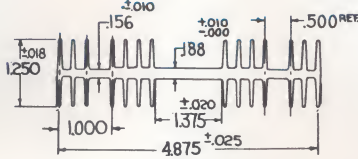
WT./FT. .706

DWG. A-1875



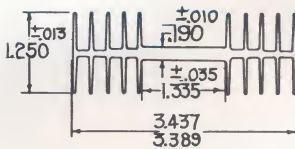
WT./FT. 1.950

DWG. B-1167



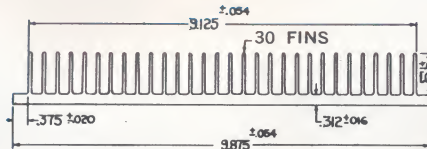
WT./FT. 1.198

DWG. A-1637



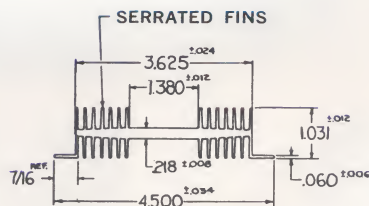
WT./FT. 5.864

DWG. B-1703



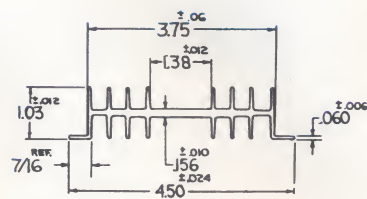
WT./FT. 1.414

DWG. A-1774



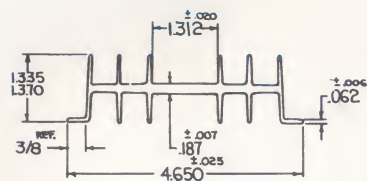
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DWG. A-1194



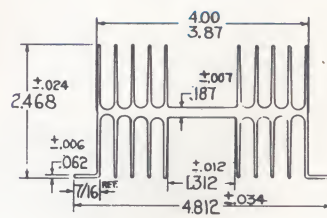
WT./FT. 1.348

DWG. A-1645



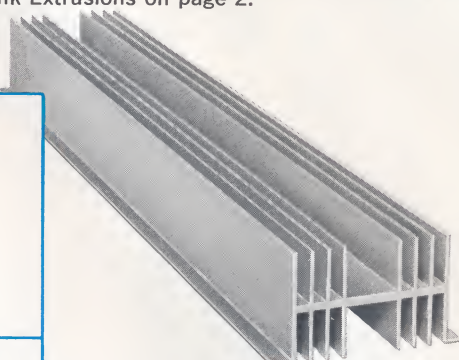
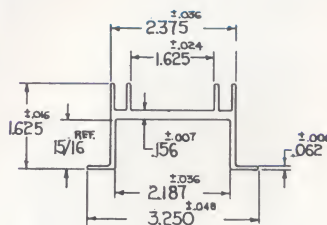
WT./FT. 2.178

DWG. A-1714



WT./FT. .877

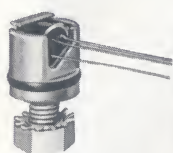
DWG. A-2308



REQUEST No. 1966 DISTRIBUTOR PRODUCTS CATALOG for complete natural and forced convection characteristics.

THERMAL RETAINERS FOR TO-5 CASES . . . NEW

SERIES 254 units for TO-5 transistors, held in by a locking spring, for power dissipations above $1\frac{1}{2}$ or 2 watts.



Type 254-SI electrically isolated and stud-mounted



Type 254-S stud-mounted

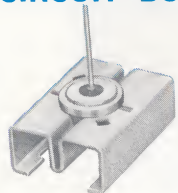


Type 254-T tapped hole



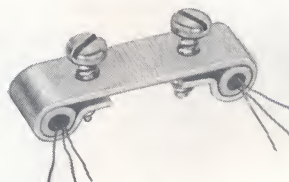
Type 254-P plain

CIRCUIT BOARD HEAT SINKS



Series 140 units provide thermal resistance as low as $10^{\circ}\text{C}/\text{w}$.

NEW . . . THERMAL CLAMP . . .
TYPE 255 units are for push/pull driver or low power output applications using TO-1 case style transistors to be clamped to a chassis or heat sink.



NEW . . . SERIES 150 units for TO-5 case take up small (.375 in.²) area on pc board. Low cost. Light weight. Case rise 40°C @ 1w with bright aluminum natural finish or 34°C rise @ 1w with black anodize finish. A screw anchors heat sink to pc board and two eyelets key it to prevent turning.



SERIES 200 . . . featherweight units of beryllium copper . . . for the entire JEDEC case tolerance range.



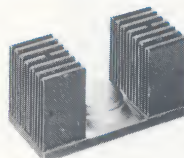
SERIES 600 . . . for pc boards and chassis exteriors.



SERIES 680 . . . can be mounted in any position. Free circulation of air from any direction. Optimum natural convection cooling per unit volume occupied above the circuit board.



COPPER FORCED CONVECTION COOLERS



SERIES 500 permit maximum heat transfer in minimum space. Use of copper, with optimized fin spacing, achieves the equivalent cooling performance of much larger aluminum units. Less mounting space consumed. Hose adapters and covers available.



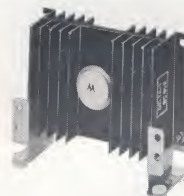
mounting space consumed. Hose adapters and covers available.

NATURAL CONVECTION COOLERS

SERIES 300 radial fin coolers for optimum cooling and flexible side-or foot-mounting. Press-fitted or stud-mounted semiconductors usable either or both ends. Compact, only 2" square, and good for stacking. (Hardware available for press fit rectifier stacks.)

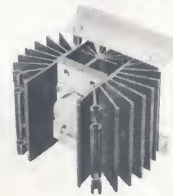


SERIES 400 units require minimum space for natural convection cooling. Also, excellent forced convection characteristics at moderate airflow.



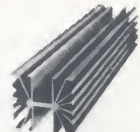
KING SIZE HEAT SINKS

. . . designed for natural convection cooling in systems requiring high reliability with latest high power rectifiers and SCRs. Black anodized except at the semiconductor mounting surface for the electrical stud connection and high current buswork.



HEAT SINK EXTRUSIONS

Available in all types of extruded heat sink designs shown in distributor products. Other types, too. Length is 3 ft. $\pm 1/4$ ".



DELTA BOND 152 THERMAL ADHESIVE

A general adhesive or for high strength bonding of materials with a high thermal conductivity interface. Bonds thermally yet isolates electrically. Effective on porous and non-porous surfaces.



THERMAL JOINT COMPOUND

Application of this compound reduces the high thermal impedance of an air gap present between the mating surfaces of a semiconductor case and the heat sink surface. Compound fills the air gap. Excellent thermal resistance: $0.05^{\circ}\text{C}/\text{w}$ for a 0.001 " film/in.².

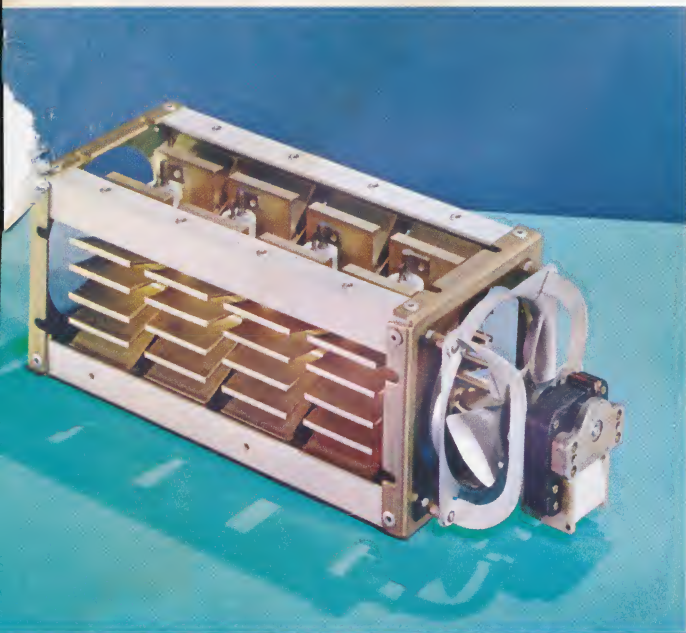


DELTA CAST 153 EPOXY CASTING RESIN

High thermal conductivity ($.002$ gm. cal./sec cm^2 $^{\circ}\text{C}/\text{cm}$), four times that of unfilled systems, and high dielectric strength (750v/mil.). Provides a thermal path from the center of the potted components to the exterior surface. A low viscosity system which fills quickly and completely. Ideal for potting semiconductors, capacitors, circuits, etc. Available either as a room or elevated temperature cure system.

WAKEFIELD Semiconductor Cooling Packages

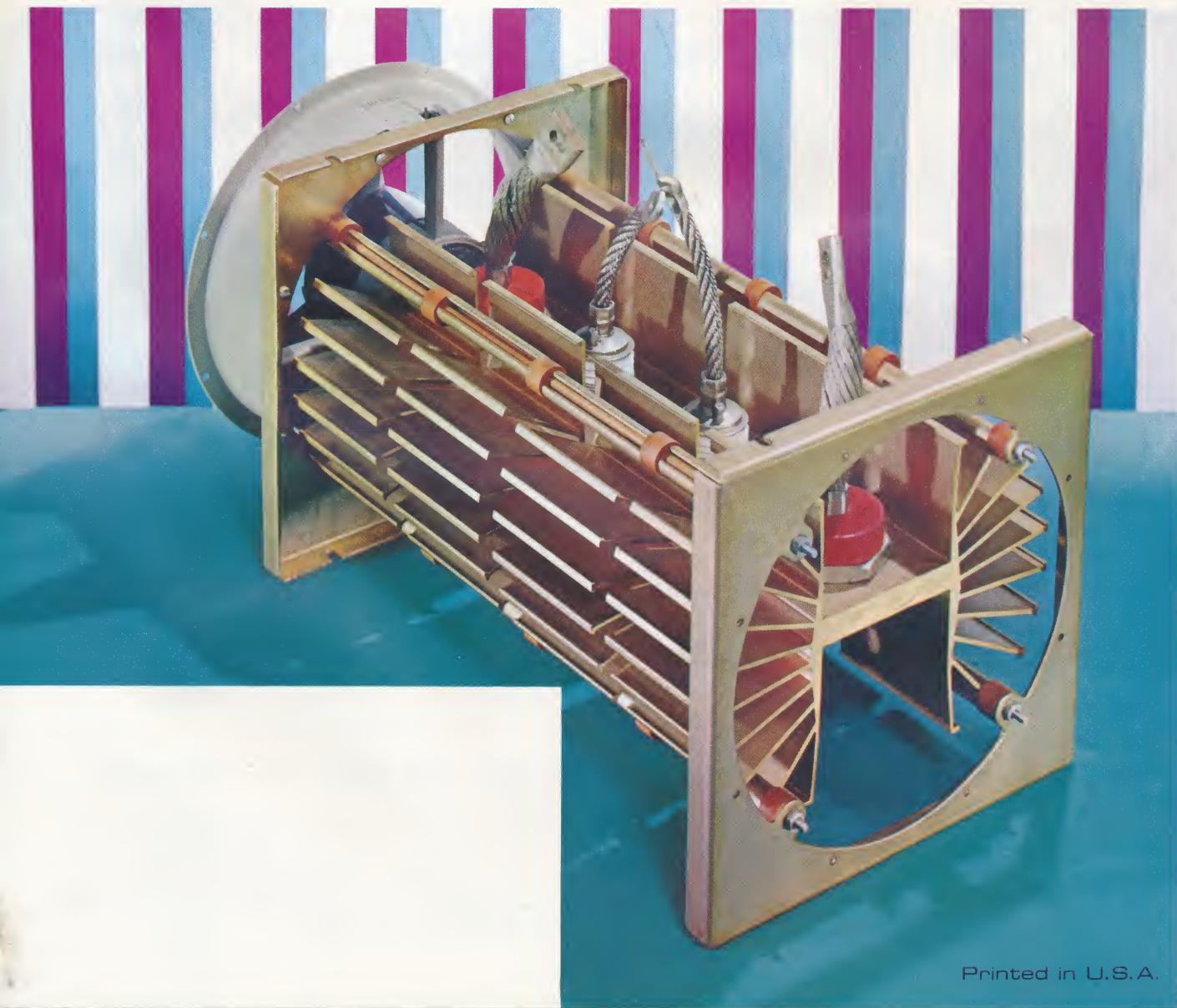
Series 1100



Series 820



Series 1000



Mr. T. Nelson, Sys. Cons.
Box 1546
Poughkeepsie, N.Y. 12603

WE 17-8A

Here is the information you requested about Semiconductor COOLING PACKAGES. If you'll answer these questions, it will help us to recommend the best and most economical solution to your application. In addition to the items in the attached literature, tooling is available for other standard air and water cooled assemblies.

Did you ask for this literature because:

- ☐ it is needed only for reference files.
☐ you have requirements to cool up to 32 or more ☐ semiconductors with a single package.
☐ you foresee problems of this sort in the next
☐ 3 mo. ☐ 6 mo. ☐ 9 mo. ☐ 12 mo.

In a single COOLING PACKAGE, how many semiconductors do you have to cool?

WATTAGE per device	NUMBER OF DEVICES		*CASE STYLE	*
	Silicon	Germanium		
0 - 10w	_____	_____	_____	1/4" stud
10 - 24w	_____	_____	_____	1/2" stud
25 - 49w	_____	_____	_____	3/4" stud
50 - 99w	_____	_____	_____	T03
100 - 199w	_____	_____	_____	T08
200 - 399w	_____	_____	_____	T036
400 - 600w	_____	_____	_____	et cetera

What is the total semiconductor heat dissipation needed?

Less than ☐ 1kw, ☐ 2kw, ☐ 3kw, ☐ 4kw, ☐ 5kw

Maximum ambient temperature for equipment operation? ____°C

X Y Z dimensions of space available for cooling assembly:

X: _____ Y: _____ Z: _____

If the WAKEFIELD 700, 800, 820 or 900 package might apply, please check off whether you'll want Type "A" easy-access Modules or Type "B" stud-mounting Modules:

☐ Type
"A"
Module



☐ Type
"B"
Module

NOTE: Both types
can be used to-
gether in a
single package.

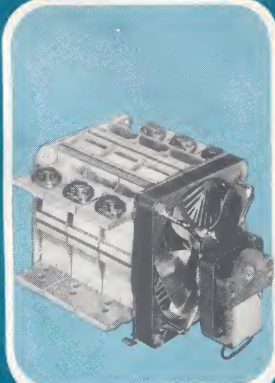
Although our Sales Representatives are listed in an enclosed bulletin, we'll be glad to have one contact you if you wish.

- ☐ Please have field representative contact me.
☐ Telephone me for appointment at _____

If you need information sooner, call us collect. Ask for Will Evans who'll put you in touch with the right man on your cooling problem.

() Send WAKEFIELD Distributor Products Catalog on items shown to the right.

WAKEFIELD Semiconductor COOLING PACKAGES



WAKEFIELD ENGINEERING, Inc.

WAKEFIELD, MASS.
01881

Phone: (617) 245-5900
TWX 617-245-9213



WAKEFIELD Heat Sinks
and Allied Products
carried in stock by
leading Electronic
Distributors:

Natural Convection
Heat Sinks

- ☐ Featherweight
- ☐ Radial Fin
- ☐ Dual-Purpose
- ☐ Circuit Board
- ☐ King Size
- ☐ Rectifier Stack Kit

Forced Convection
Coolers

- ☐ Also, hose adapters
and covers

- Heat Sink Extrusions
- Type 120 Thermal
Joint Compound
- Delta-Bond 152
Thermally Conduc-
tive Adhesive

For COOLING PACK-
AGE information, con-
tact the Factory or the
local Sales Representa-
tive.

